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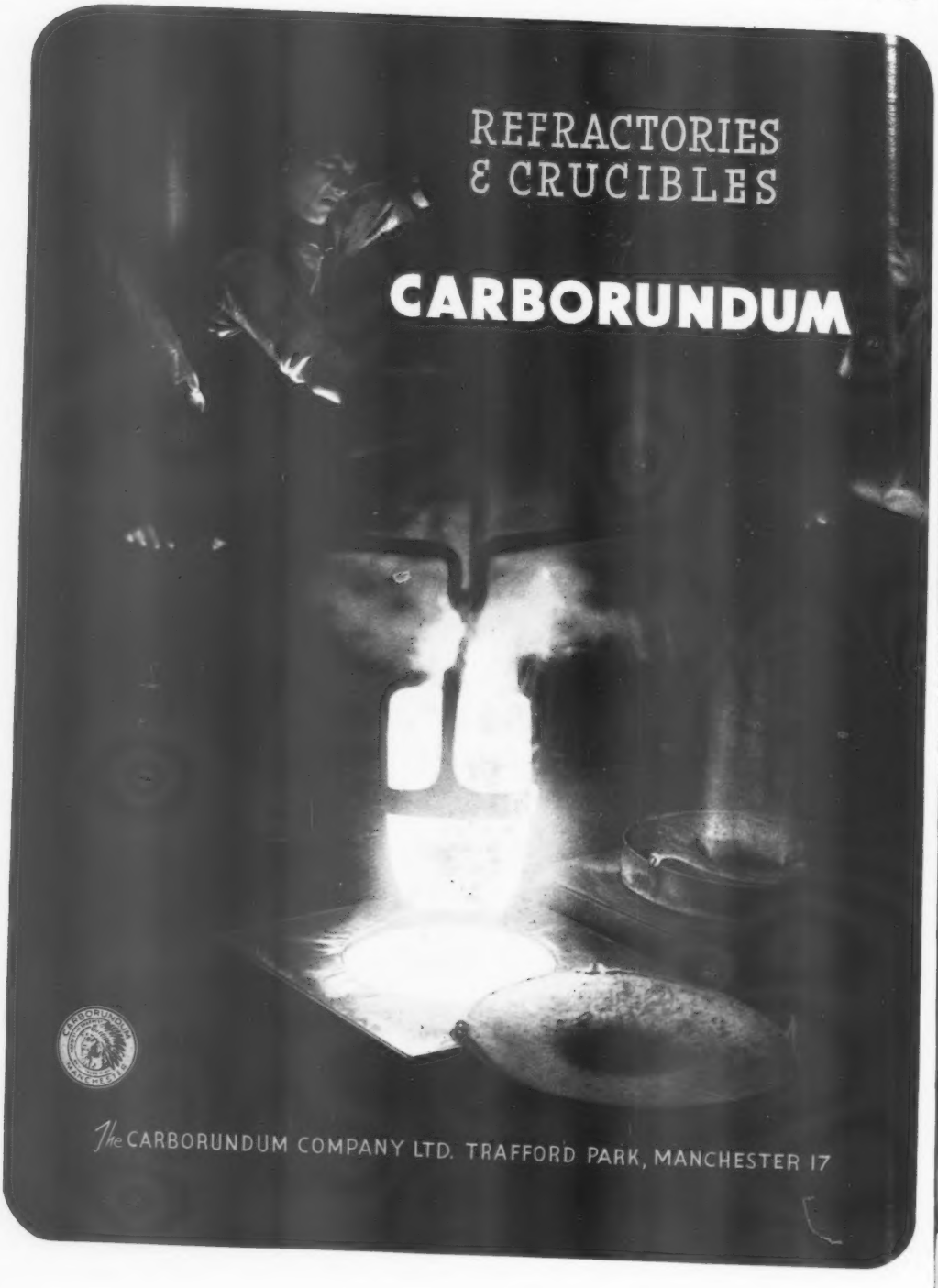
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Corrosion of Buried Cast-iron Pipes

Cast-iron pipes constitute a significant proportion of the total output of the ironfoundry industry. It has been known for some time that deterioration in underground mains has been reported in an increasing measure. The subject has been dealt with in an interim report* of a departmental committee and just published by H.M. Stationery Office. Though the report confines itself to cast iron, it is stated that "the causes leading to deterioration in cast and spun iron pipes are also inimical to unprotected wrought and steel pipes." The main source of trouble is in rural areas and seems to be due to a microbiological attack, though other factors also intervene. In built-up areas the problem does not appear to be as great. Moreover, the smaller-diameter thinner-sectioned pipes have given the most trouble. Rigidity can be an adverse factor and flexible joints can be used to give a measure of elasticity and, also, if an insulator such as rubber be incorporated, some protection can be given against the potentially deleterious effect of stray electric currents.

The report examines the two methods of making pipes—spinning and vertically casting. The spun pipes, because of their greater inherent mechanical strength, have usually been made somewhat thinner than the vertically-cast variety, especially if made to B.S. 1211:1945 and B.S. 78:1938 respectively. The report shows the increased cost of spinning thicker-sectioned pipes. Related to the general cost of replacing an existing main, the increases would seem to be economic, for it has been shown that corrosion is—*inter alia*—a function of mass. The report devotes a good deal of attention to the protective coatings applied to the pipes. One of the major troubles, it seems, is the breaking—or wearing—away of this dressing during transport between the foundry and the actual site. There is a preference for road transport, as this method eliminates the danger of skin destruction through shunting. When sending rainwater goods from Falkirk to London by rail; the loss from breakages is particularly high.

The report is completed by a series of conclusions and the implementation of these should not exceed current costs by more than 25 per cent. The recommendation is that remedial measures should be chosen from amongst the following:—The use of pipes of a greater wall thickness than the standard spun iron pipes; the use of flexible joints; the use of protective coatings of a greater thickness than the normal coating; the use of reinforced bituminous coatings; the provision of a 3-in. surround of good-quality cement concrete; if available locally, the provision of a 12-in. surround of chalk or of suitable granular material, generally in conjunction with other appropriate protective measures, and the use of cathodic protection to supplement protective coating, but not as the sole means of protection. There is nothing particularly frightening about this interim report, which rightly stresses the need for additional research and the reinforcement of data by standardised statements from the authorities as to failures due to rapid corrosion as and when they arise. Some rural district councils have the greatest difficulty in raising money for the relaying of pipelines, as the initial expenditure presupposed a long life. However, it is a costly job replacing mains, and the recommendations made are essentially practical and well worthy of protracted experiment.

* Deterioration of Cast Iron and Spun Iron Pipes. Price 3s. 6d.

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Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

STEELFOUNDING PRODUCTIVITY AND HIGHER EARNINGS

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—May I make a few brief observations in reply to Mr. F. A. Martin's letter published in your issue of June 22, 1950? Had Mr. Martin taken the trouble to enquire, he could have obtained a copy of my report presented to the annual delegate meeting of my union. He could then have read in full the relevant sections on production and productivity, instead of relying on excerpts appearing in the public Press. With fuller knowledge of what was actually contained in my report, he would, perhaps, have been more cautious in his conclusions.

Far from denying that piecework earnings reflected increased productivity, I asserted it was so, but I also asserted that higher earnings so obtained were not in ratio to the total productivity increase for the industry and that it was not reflected at all in the basic rate inclusive of national bonus. I hardly think Mr. Martin will dare deny the accuracy of that statement.

My report was not particularly concerned with the steel foundry or any other single section, but with founding in all metals. Whether my conclusions correspond with Mr. Martin's views is immaterial, but comment should at least be based on the factual content. Improved technology can, and does, increase the volume of production with less expenditure of time and effort. On the other hand the working day is not necessarily any less strenuous nor does it automatically follow that earnings are increased. Saying this does not imply opposition to technical advance, or is there anything in my report that could be construed in that way.

Neither is it stated in my report that unemployment necessarily arises from increased productivity, but, and it is here that I shall continue to disagree with Mr. Martin, it does arise from the fact of production capacity being greater than can be absorbed in the markets and from the lack of a planned distribution of the products of industry.

Yours, etc.,
J. GARDNER,
General Secretary.

Amalgamated Union of Foundry Workers,
164, Chorlton Road, Brooks's Bar,
Manchester, 16.
June 28, 1950.

1951 I.B.F. Conference Papers

The council of the Institute of British Foundrymen is prepared to receive offers for Papers for presentation at the 48th Annual Conference to be held at Newcastle from June 12 to 15, 1951.

Members and non-members who contemplate offering Papers are asked to communicate immediately with the secretary of the Institute, St. John Street Chambers, Deansgate, Manchester, 3, who will forward them a copy of the Institute's publication "Notes for the Guidance of Authors of Papers." It is desirable that all formal offers of Papers should be sent to the secretary not later than October 1 so that they can be considered by a meeting of the appropriate committee which will be held later in the month of October.

THE NAME of the Ranger Engines Division of the Fairchild Engine & Airplane Corporation, located at Farmingdale, Long Island, U.S.A., has been changed to Fairchild Engine Division.

Forty Years Ago

Our issue for July, 1910, contains a measure of criticism of the exhibition and competitions organised by the Worshipful Company of Founders, inasmuch as the industry did not supply a sufficient number of exhibits covering the engineering trades. The artistic side however was well represented. A second leader deplores the fact that "the majority of the foundry moulding machines here used are not of British make." It has taken two world wars to remedy this deplorable condition. There is also an account of the formation during June of the *Association Technique de Fonderie*. Mr. Barthe was elected president; Mr. Roger, vice president, and Mr. Plichon treasurer. The temporary honorary secretary was Mr. Didier. We congratulate the *Association* on its 40th anniversary. There is a full illustrated description of an American moulding machine capable of handling moulds weighing up to 25 tons. Another article describes the foundry of the Daimler Company and the making of automobile castings, most of which were made on French moulding machines, whilst a third reports on the dispatch to Italy of a 4,500 ton press, the cast-steel base plate for which weighed 56½ tons. From the description of the "Founders" we learn that the 1900 exhibition was the third of a series, earlier ones being held in 1880 and 1898. One of the clauses was "all to be cast from the crucible." The first prize was won by Mr. A. Stanley Young for a medal bearing the arms of the Company and on the reverse side the pouring of a mould. A lady won the second prize.

On the commercial side, the creation of the National Steel Foundry Company, Limited at Leven and the doubling of the foundry capacity of Mather & Platt, Limited, are reported.

Localised Blowholes in Dry-sand Castings

Mr. P. Nicholas, writing in *Fonderie*, refers to some correspondence wherein the writer had noted the presence of isolated blowholes in some dry-sand castings. It would appear that these faults are due to the fact that the mould received a dressing on leaving the stove and was not re-dried. No doubt there had been a concentration of dampness at some point or other, due to the use of brush several times in the same area. It should be unnecessary to recall that a cube of water measuring one millimeter—a minute quantity—is changed on heating to 400 deg. C.—an arbitrary figure—to a volume of more than 300 cubic millimetres. The rapid evolution of such a quantity of gas at a point on the surface of a mould can but result in the formation of a blowhole.

A SPECIAL EXHIBITION is being held at the Science Museum, South Kensington, London, S.W.7, from July 7 to September 30, covering the theme "Metals in the Service of Man." The Science Museum is open from 10 a.m. to 6 p.m. on weekdays and from 2.30 to 6 p.m. on Sundays.

A MEETING of The Association of Bronze and Brass Founders will be held at the Midland Hotel, Manchester, on July 11, commencing at 11 a.m. Luncheon has been arranged for 12.30 p.m. to enable members to attend a showing of the film "Bronze Founding" in the Reynolds Hall, College of Technology, at 2.30 p.m., to which boys of school-leaving age have been invited and which will be introduced by the Lord Mayor of Manchester.

Sand Casting of Conductivity Copper*

By W. H. Glaisher, B.Sc., A.I.M.†

Experiments on the effects of various degassing and deoxidation treatments on the properties of sand-cast test-bars made from melts of electrolytic copper melted under charcoal covers are described. It is shown that bars of high density, electrical conductivity and mechanical properties may be made by melting under charcoal, degassing with marble chips or manganese ore, and deoxidising with sufficient phosphor-copper to leave a residual phosphorus content of 0.01-0.02 *per cent. Deoxidation with magnesium or calcium is not recommended.*

FOR A NUMBER of applications of copper for sand castings, deoxidised copper must be used in order that there shall be no danger of embrittlement at high temperatures. Where such castings are required to have high conductivity, two difficulties commonly experienced in the production are (1) control of the amount of residual deoxidant (and thus of conductivity), and (2) control of porosity in the castings. Two methods may be used in attempts to control these factors:—

(*a*) The copper may be melted under charcoal, in which case the oxygen content is very low and the small amount of deoxidant necessary can be calculated with some accuracy. A degassing treatment is usually needed to prevent porosity in the casting due to hydrogen evolution.

(*b*) The molten copper may be oxidised, either with fluxes or by exposure to the atmosphere, in order to reduce the hydrogen content to harmless amounts. A larger and less-accurately known amount of deoxidant is necessary in this case, and there is considerable likelihood of too much being added, with resultant loss of conductivity.

In either case, generous feeding heads must be provided, on a scale similar to that used for aluminium bronze and manganese bronze, to avoid porosity in the castings due to unfed freezing shrinkage.

This Paper describes some tests using the first method, in conjunction with two methods of degassing which have been found useful for bronzes and gunmetals.[1] Degassing by nitrogen blowing was not used, although this is likely to give good results, since this has not yet become a widely-used method.

Experimental Details

Melts were made in a gas-fired crucible furnace, and except where otherwise stated were of 90-100 lb. of cathode copper. Sand-cast D.T.D. bars were made, using green Mansfield sand, and a pouring temperature of 1,200 deg. C. At least two bars were poured from each melt. Directly the copper melted, small lump charcoal ($\frac{1}{2}$ in. to 1 in.) was added to form a layer 1 in. to 2 in. deep, and this was maintained during the subsequent heating and usually also during pouring, being kept from entering the casting by means of an iron skimmer coated with alundum. It was found that very low oxygen contents were obtained by this method. Two methods of attaining at the same time the desired low content of hydrogen have been used.

(*a*) *Degassing with marble chips.*—This is essentially a scavenging method, applied by means of a plunger containing marble chips. The plunger used is a salamander tube $1\frac{1}{2}$ in. bore, $\frac{3}{8}$ in. wall thickness and 3 ft. long, closed at one end. A weight of marble chips equal to 0.25 per cent. of the weight of the charge is used. This is wrapped in copper foil to form a packet which is placed just inside the open end of the salamander tube, being held there by suitably bending the foil. With the metal at 1,200-1,250 deg. C. and still in the furnace, some of the charcoal is removed so that the remainder can be drawn aside sufficiently to insert the plunger, open end down, without trapping charcoal under it. An empty crucible inverted on the plunger gives it sufficient weight to keep the open end near the bottom of the melt. A vigorous evolution of carbon dioxide occurs, although not sufficient to cause splashing through the charcoal cover. After five minutes the plunger is removed, a small amount of deoxidant added (see Table I), the crucible removed from the furnace, and the metal poured when the correct temperature is reached.

(*b*) *Degassing with manganese ore.*—This method is partly a scavenging and partly an oxidising treatment. Manganese-ore powder (crude manganese dioxide) equal to 1 per cent. of the weight of the charge is placed in the bottom of the crucible before the copper is put in. Melting and casting are carried out as usual, the charcoal and the small amount of deoxidant being added as above. In this case removal of hydrogen is due to the combined effects of oxidation and scavenging. The manganese ore evolves a stream of oxygen and probably other gases also for up to half-an-hour after the copper is molten.

Results and Discussion

(*a*) *Degassing with marble chips.*—Table I gives details of results obtained by this method.

* This Paper, a communication from the British Non-ferrous Metals Research Association, was presented to the Annual Conference of the Institute of British Foundrymen. The work described was made available to members of the B.N.F.M.R.A. in a confidential report issued in 1945.

† Research investigator, B.I.S.R.A., London: formerly research investigator, B.N.F.M.R.A., London.

TABLE I.—*Melts Treated with Marble Chips.*

Mark.	Deoxidant added.	Remarks.	Density, gm. per cc.	Final percentage P.	Percentage conductivity I.A.C.S.
1	0.02 per cent. P	—	8.84	0.012	95
9	0.02 per cent. P	—	8.80	0.016	90
6	0.02 per cent. P	Surface exposed to air for 5 mins. after adding P	8.10	0.006	87
12	0.03 per cent. P	Charge of ingots from melt 9, *i.e.*, containing 0.016 per cent. P. Bars cast at start and finish of pouring. Surface exposed to air during pouring. Time between pouring bars, 2 mins.	1st 8.82 2nd 8.83	0.024 0.012	84 89
32	0.02 per cent. P	As melt 12, but cathode copper charge	1st 8.86 2nd 8.86	0.014 0.010	84 90

The melts were sufficiently free from hydrogen to give high densities when properly deoxidised, for which an addition of 0.02 per cent. phosphorus was sufficient, provided the melt was not exposed to air. Five mins. exposure to air reduced the phosphorus content to a low value, allowing sufficient absorption of oxygen to cause gross porosity owing to reaction with the hydrogen in the metal on cooling. Even 2 min. exposure of the surface of the melt to air during casting caused an appreciable loss of phosphorus (melts 12 and 32) and it is clear that to obtain consistent results the surface must be protected in some way during pouring, either with charcoal as above, or by means of a gas flame.

High conductivity figures were obtained with this method. A residual phosphorus content of about 0.01 per cent. appears to be necessary to ensure sufficient deoxidation, and this gives a conductivity of 90-95 per cent. Oxygen estimation on a dip sample taken from one of these melts after treatment with marble showed an oxygen content of 0.0014 per cent., the sample containing 0.010 per cent. phosphorus.

This method is therefore capable of giving castings which are both sound and of high conductivity.

(*b*) *Degassing with manganese ore.*—Table II gives some results.

Again it is seen that when the final phosphorus content of the melts was above 0.01 per cent. high densities were obtained. Despite the presence of the strongly-oxidising manganese-dioxide the charcoal on the surface of the melt keeps the oxygen content low enough for efficient deoxidation to be achieved by the addition of 0.02 per cent. phosphorus. Oxygen estimations on samples taken from such melts before the addition of the phosphorus gave figures of 0.0005 per cent. or less, with even smaller figures after the phosphorus addition.

However, where high densities were obtained, conductivity figures were not as good as those from melts of comparable phosphorus content degassed with marble chips. Some of the melts were deoxidised partly with zinc and partly with phosphorus, and in these cases there was some pickup of manganese from the manganese ore, but even where zinc was not added (melts 27 and 31), somewhat lower conductivities were obtained. The reason for this is not apparent.

Where manganese entered the metal this was the chief reason why low conductivities were obtained,

TABLE II.—*Melts Treated with Manganese Ore (i.e., 1 per cent. Manganese Ore Charged with the Metal).*

Mark.	Deoxidant added.	Remarks.	Density, gm. per cc.	Final percentage P.	Final percentage Zn.	Final percentage Mn.	Percentage conductivity I.A.C.S.
25	0.01 per cent. P		*1st bar 8.38 2nd bar 8.67	0.005 0.005	—	nil	90 95
27	0.02 per cent. P		1st bar 8.85 2nd bar 8.88	0.012 0.009	—	nil	83 84
31	0.02 per cent. P		1st bar 8.82 2nd bar 8.84	0.013 0.013	—	trace	87 87
28	0.1 per cent. Zn 0.01 per cent. P	Charge of ingots from previous melts	1st bar 8.89 2nd bar 8.89	0.012 0.011	0.09	0.03	84 82
22	0.4 per cent. Zn 0.01 per cent. P	do. Surface of metal exposed to air during pouring.	1st bar 8.81 2nd bar 8.91	0.017 0.013	0.28	0.09	70 72
19	0.4 per cent. Zn 0.01 per cent. P	15 lb. melt. No charcoal used. 2 per cent. manganese ore charged.	8.60	0.004	0.16	nil	93

* Bars cast at start and finish of pouring

TABLE III.—*Deoxidation with Calcium and Magnesium.*

Mark.	Deoxidant added.	Remarks.	Density, gm. per cc.	Final percentage Ca or Mg.	Percentage conductivity I.A.C.S.
29	0.05 per cent. Ca	Charged 1.25 per cent. MnO_2. Charcoal cover throughout. Ca added 10 mins. before pouring.	1st bar 8.43 2nd bar 8.51	—	93 92
30	0.05 per cent. Ca	Charged 1 per cent. MnO_2. Charcoal cover throughout. Ca added 1 min. before pouring.	1st bar 8.16 2nd bar 8.32	Trace	89
33		Degassed with marble chips. Charcoal cover throughout.			
	(*a*) 0.01 per cent. Mg	1st bar. 1 min. after (*a*)	7.79	0.004	80
	(*b*) further 0.02 per cent. Mg	2nd bar. ½ min. after (*b*)	8.84	0.01	97
	(*c*) further 0.02 per cent. Mg	3rd bar. ½ min. after (*c*)	8.88	0.05	94
		4th bar at end of pouring	8.87	—	94

since the effect of the residual zinc content is small compared with the known effect of manganese. Smith and Palmer[2] give curves showing that a reduction of conductivity by 5 per cent. is caused by the presence of 0.04 per cent. manganese, while 0.3 per cent. zinc is required to produce a similar effect. High conductivities were obtained with melts 19 and 25, but in these cases deoxidation was insufficient and the bars were unsound.

This method is less satisfactory than the use of marble chips, but high density with moderately high conductivity can be obtained. Deoxidation with phosphorus only is preferable.

(*c*) *Deoxidation with calcium and magnesium.*—Both these elements are known to have high affinities for oxygen, and relatively small effects on the conductivity of copper. According to Schumacher, Ellis and Eckel,[3] 0.1 per cent. calcium reduces the conductivity of annealed copper by only 2 per cent., while Skowronski[4] gives curves showing that 0.03 per cent. magnesium reduces the conductivity of wrought and annealed copper from 101 per cent. to 99 per cent., and 0.1 per cent. reduces it to 94 per cent. I.A.C.S. One or two tests of these metals as deoxidants were therefore made, calcium being added as 35 per cent. calcium/copper alloy, and magnesium as metal. The results are shown in Table III.

The addition of 0.05 per cent. calcium did not reduce the oxygen content of the melts sufficiently for high densities to be obtained. In both the melts a very strong oxide skin formed on the molten metal, which poured very sluggishly, causing lapped surfaces in the castings. In view of this, larger additions of calcium were not made. It should be noted, however, that other workers, notably Schumacher, Ellis and Eckel,[3] have reported excellent results when using calcium.

Additions of 0.03 and 0.05 per cent. Mg (total) gave bars with high density and high conductivity. Although the metal when in the crucible had a visible oxide skin, the pouring stream was quite clean, and the castings had good surfaces.

(*d*) *Mechanical Tests.*—Tensile tests were made on some of the bars cast, with the results given in Table IV.

Normal properties were obtained where phosphorus was the deoxidant. The bars containing calcium were unsound, and gave very poor properties, with discoloured fractures and cracks at many points along the test specimens. Of the bars containing magnesium, that to which 0.03 per cent was added (33B) had normal properties, but with the 0.05 per cent. addition (33D) the result was poor, and micro-examination showed considerable inclusions, which were not identified, but were probably deoxidation products.

Summary

Sound copper castings of simple shape (*i.e.*, the D.T.D. bar) have been produced with high conductivity by two methods. Both involved melting under charcoal, degassing to remove hydrogen, and adding a small amount of deoxidant before pouring. The method of degassing by plunging marble chips was the better.

TABLE IV.—*Tensile Test Results.*

Mark.	Degassing treatment.	Density, gm. per cc.	Residual percentage P.	Residual percentage others.	Percentage conductivity I.A.C.S.	U.T.S., tons per sq. in.	Elongation per cent. on $4\sqrt{A}$.
3	$CaCO_3$	8.84	0.012	—	95	11.4	48*
10	,,	8.81	0.016	—	90	11.8	44
27	MnO_2	8.88	0.009	—	84	11.9	45*
31	,,	8.82	0.013	—	87	10.7	37*
28	,,	8.89	0.011	0.09 Zn 0.03 Mn	82	11.3	56
29A	MnO_2	8.43	—	Ca (not estimated)	93	7.9	13
29B	,,	8.51	—	Ca (not estimated)	92	7.5	11
33B	$CaCO_3$	8.84	—	0.01 Mg	97	16.7	51
33D	,,	8.87	—	0.05 Mg	94	8.9	18

* Broke outside gauge length.

Sand Casting Conductivity Copper

The amount of the deoxidising element lost in deoxidation was small, so that under the constant conditions of the tests the correct addition could easily be determined. This was such as to leave 0.01-0.02 per cent. (when phosphorus was used) in the metal. With different sizes of melt (from the 100 lb. used) slightly different additions might be necessary, but these should be constant under constant conditions.

One melt deoxidised with magnesium gave good results for soundness and conductivity, but this method cannot be recommended without further tests, since poor mechanical properties were obtained with the higher amount of magnesium.

Calcium used as deoxidant was not satisfactory under the conditions of test.

Whatever the treatment of the metal, sound castings will only be obtained if adequate feeding is provided.

Acknowledgments

The Author's thanks are due to the director and council of the British Non-ferrous Metals Research Association for permission to publish this Paper.

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1 W. A. Baker and F. C. Child. *J. Inst. Metals*, 1944, **70**, 349.
2 C. S. Smith and E. W. Palmer. *Trans. Amer. Inst. Min. Met. Eng.*, 1935, **117**, 225-247.
3 E. E. Schumacher, W. C. Ellis and J. F. Eckel. *Trans. Amer. Inst. Min. Met. Eng., Inst. Metals Div.*, 1929, 151.
4 S. Skowronski. Chart of effects of various elements on conductivity of copper, published in a paper by L. L. Wyman, *Gen. Elec. Review*, March, 1934, **37** (3), 120-129.

(As the Author was abroad, this Paper was presented to the conference by Mr. B. W. Peck).

DISCUSSION

MR. Z. STOKOWIEC congratulated the British Non-ferrous Metals Research Association on having published the Paper, because some founders still seemed to believe that casting in high-conductivity copper involved some kind of black magic. His experience was that some oxygen was needed in copper. Therefore, he suggested the use of wire bars instead of cathode copper, a procedure which would be easier for the ordinary foundry, and there would be less trouble with hydrogen.

MR. B. REYNOLDS said that he had as a matter of economy tried to use wire-bars discard instead of electrolytic copper, and invariably the conductivity had dropped by from 5 to 10 per cent. The conclusion arrived at, after analysing the wire-bar scrap, was that it collected very small amounts of impurities, which lowered the conductivity. Incidentally, he had not been quite so fortunate as had the Research Association in getting even 90 per cent. conductivity; the average at his works was only about 85 per cent. His firm used the I.B.F. bar instead of the D.T.D. bar for routine tests.

MR. PECK felt that Mr. Reynolds had answered the question relating to the use of wire-bar material when he had referred to impurities.

MR. STOKOWIEC urged that oxygen helped conductivity. So far as impurities were concerned, if one used wire bars, one should get the same amount of impurities as in electrolytic copper, except for oxygen.

MR. PECK did not think that the presence of oxygen would increase the conductivity of copper; he agreed, however, that the presence of oxygen during melting would minimise hydrogen absorption, and, provided that the melt was subsequently deoxidised before pouring, would have a beneficial effect on the soundness of the casting.

On the motion of the chairman, seconded by Mr. Stokowiec, the thanks of the meeting were accorded to Mr. Peck for having presented the Paper.

Electricity Load Spreading

Next Winter's Arrangements

Despite great efforts to expand electricity generating capacity, the increase in demand during recent years has generally been such as to offset the increased supply of current. The expansion in generating capacity is now beginning to overtake the increase in demand, but there will still be a substantial deficit during the peak periods next winter unless the different classes of consumers take special steps to reduce the load. In these circumstances, the electricity sub-committee of the National Joint Advisory Council have recommended that, if the risk of extensive dislocation of industry is to be minimised, load-spreading arrangements will be necessary next winter. The arrangements should, however, prove less onerous than those in force last winter.

The sub-committee consider that during next winter the position as regards the midday peak will be so improved as to warrant confining the peak hours for industry during the morning to the period 8 to 9.30 a.m. although care in the use of electricity will still be necessary up to noon. During the hours 8 to 9.30 a.m. for the months of December, January and February, a reduction in load of at least 10 per cent. will be required of industry. The afternoon peak hours will remain unchanged at 4 to 5.30 p.m., when a similar reduction of at least 10 per cent. will be required during the period December to mid-January.

Regional Boards will have discretion to require a reduction in load of more than 10 per cent. at these times where local circumstances make this necessary, and the sub-committee consider that in many cases the load-spreading requirements during December, January and February will have to be substantially the same as they were last winter. For the remainder of the period October to March inclusive, Regional Boards will have complete discretion to determine the percentage reduction necessary. The basis on which the target reduction in load is to be calculated has been altered. Instead of relating to demand in the winter of 1946-47, the percentage reduction will now relate to the maximum demand which would have been made last winter had there been no reduction then by way of load-spreading. In view of the inconvenience and difficulties to employers and workpeople involved by the staggering of hours of work, Regional Boards are to be asked to pay special regard to the need to avoid this method of load-spreading as far as possible.

The task of reducing the load cannot be borne by industry alone, and Regional Boards and other authorities are to be requested to arrange for commercial and domestic consumers to contribute equally with industry by effecting the same percentage reduction in demand during peak periods.

Where is Cast Iron Going To?

By P. A. Russell, B.Sc.

(*Continued from page* 702.)

Damping Capacity of Nodular Irons

IT IS FREELY acknowledged that the capacity of nodular irons for damping-out vibrations is very poor compared with flake-graphite iron and the material is nearly as bad as steel.[2]

As a practical example of this the Author had prepared a series of eight tubes, in the eight materials used for the transverse test (excluding mild steel), and he exhibited them on a stand in the same order, except that the annealed nodular had been brought into position six. All these tubes had been accurately ground to identical dimensions. When these were struck with a hammer it was noted that No. 1 was almost completely dead and that the "ring" increased as the strength of the iron increased, with a marked step in the increase as soon as the nodular irons were reached, with the "as-cast" cerium and magnesium nodular iron giving a very considerable "ring." Damping capacity is an important factor in machinery design. It will be noticed that, in Table I, dealing with these irons, the highest Brinell hardness is that of the "as-cast" magnesium-treated nodular iron. All the test-bars, etc., were turned reasonably easily with tipped tools, but differences in ease of machining naturally were observed. D. J. Reese[3] says: "Under equivalent conditions of chemistry and metallurgy, nodular iron is superior for machinability to malleable or cast iron. A 375-Brinell nodular iron has been machined easily where a 275-Brinell cast iron presented difficulty." Little evidence has yet been produced as to the wear resistance of nodular irons, but Reese claims that it is equal to that of flake-graphite iron. In this connection, the matrix structure, whether ferritic or pearlitic is, of course, of great importance. The brake-drum test, reported by Austen,[4] does not seem to be favourable to nodular iron.

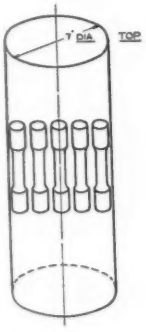

FIG. 16.—*Position of Cutting Test-bars from the 7-in. dia. by 24-in. Bar.*

One other feature of nodular irons, which has not yet had much prominence, is its regularity of strength throughout thick sections. The British Cast Iron Research Association has made available to the Author the results of tests on five bars cut from a 7 in. diam. by 24 in. long bar in the manner shown in Fig. 16. The results are given in Table III, which compares four flake-graphite irons with three nodular irons. The results in separately-cast 1.2 in. diam. bars are not given, but it will be recalled that the normal tensile strengths of cerium- and magnesium-nodular irons are 35 and 45 tons per sq. in. respectively. Thus the usual falling-off due to mass occurs in nodular irons, in common with all cast materials. These figures are confirmed by Austen[4] as shown in Table IV.

TABLE IV.—*Strength of Bars from Various Sections of Nodular Graphite Iron (C. R. Austen*[4]*).*

Diam. of bar, in.	1.2	4	6		
			Edge	Mid. radius	Centre
Tensile, tons per sq. in.	53	41	39	39	39
Brinell hardness	293	280		280	

A parallel set of experiments on various types of flake-graphite iron similar to those in Table I, items 3 to 5, were carried out, test-bars being taken from the bottom centre and the absolute centre of a 7½ in. diam block, as shown in Fig. 17, and compared with separately cast 1.6 in. diam. bars. The results are shown in Table V, and, whilst the falling off in strength given in Table III is confirmed, these irons give much more favourable results (with regard to retention of a reasonable strength in heavy sections) than the flake graphite irons in Table III.

TABLE III.—*Tensile Strength in Tons per Sq. In. of Bars Cut from 7 in. Diam. by 24 in. Long Bar (see Fig. 16).*

Composition, per cent.						Treatment.	Distance radially from edge.				
T.C.	Si.	S.	P.	Mn.	Other elements.		¾ in.	1 in.	1¾ in.	2¾ in.	3¼ in.
3.07	1.36	0.112	0.044	0.84	—	None	11.5	10.9	9.2	9.1	8.1
3.20	1.26	0.076	0.042	0.79	—	A	10.6	10.4	9.3	9.3	8.3
3.30	1.15	0.095	0.058	0.66	Cr 0.42	A	13.6	13.0	11.0	11.2	10.0
3.10	1.31	0.118	0.045	0.81	Ni 1.39 Cr 0.38	A	14.8	13.6	13.0	12.2	11.2
3.61	2.59	0.006	0.039	0.36	Ce 0.027	B	21.2	21.3	21.0	21.0	21.0
3.46	2.90	0.004	0.043	0.43	Ce 0.034	C	22.7	22.4	22.5	22.3	23.0
3.10	1.37	0.008	0.035	0.76	Ni 1.51 Mg 0.04	D	38.0	37.5	34.2	36.0	—

Treatments: A—Inoculated with 80 per cent. ferro-silicon; B—Cerium; C—Cerium and S.M.Z.; D—Nickel-magnesium and ferro-silicon.

TABLE V.—*Strength of Bars Cut From 7½ in. Diam. by 10 in. Long Bar, Compared with Separately-cast 1.6 in. Diam. Bar (see Fig. 17).*

Approximate composition, per cent.						Inoculated.	Tensile in tons per sq. in.		
T.C.	Si.	S.	P.	Mn.	Other elements.		Separate.	Bottom.	Centre.
3.22	1.34	0.12	0.7	0.6	—	No	16.70	13.01	12.26
3.00	1.16	0.13	0.3	0.6	—	No	18.31	17.00	14.49
2.86	2.30	0.05	0.1	0.7	Ni 1.5	Yes	18.54	19.23	15.34
2.81	2.20	0.05	0.1	0.7	Ni 1.36 Mo 0.42	Yes	25.04	20.66	17.40

The microstructures of the separately-cast bar and the centre bar of the fourth iron in this table are shown in Figs. 18 and 19. It will be noted that the

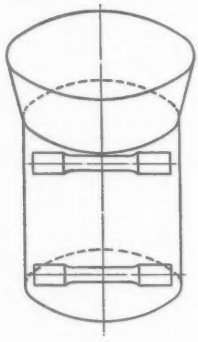

FIG. 17.—*Position of Cutting Test-bars from the 7½-in. dia. by 10-in. Block.*

difference is almost entirely one of graphite size and therefore of crystal size. There is also more ferrite in the heavy section. All these tests were taken from irons in regular commercial production.

Future of Cast Irons

Having completed an examination of developments in cast iron to date, it is proposed to revert to the theme, "Where is Cast Iron Going To?" First, nodular irons: In this connection enough has been said here and in other places to show that nodular iron is not a very serious competitor for flake-graphite iron, or even for high-duty iron, except to a very limited extent. The original idea that all cast irons might be nodular and that one would be able to take a cast-iron gutter and drop it from the top of a building without it breaking has now been dispelled.

It is also clear that nodular iron is a new material with its own characteristics and should be treated as such—something which will do what neither flake-graphite iron nor malleable cast iron, and nor, possibly steel, cannot do at present. This is what one enthusiastic American says (D. J. Reese[3]):—

> What are the impacts of this development on the foundry industry? In 1948, the ferrous foundry industry produced approximately 15½ million product tons of component parts in steel, malleable iron and cast iron. In round figures, the steel industry produced 61½ million product tons of finished and semi-finished steel. The total product tons of the foundry and steel industries of ferrous materials would be something like 77 million product tons, of which 20 per cent. represents foundry and 80 per cent. industry production.

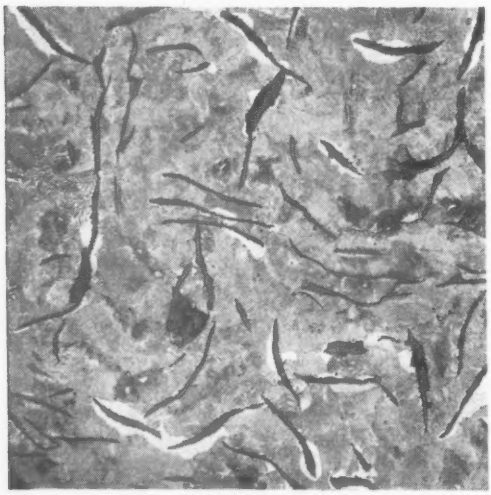

FIG. 18.—*Microstructure of Iron No. 4 (Table V). Separately-cast Bar, × 100.*

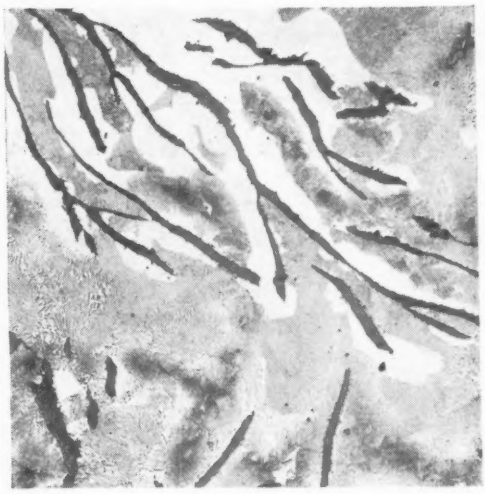

FIG. 19.—*Structure of Iron No. 4 (Table V). Bar from Centre of Block, × 100.*

If America were to remain static in its industrial growth, one could forecast that the 20 per cent. foundry portion of this huge industrial pie would increase, while the 80 per cent. steel portion would decrease. Note that a small shift of 1 or 2 per cent. toward the foundry would mean as much as 1½ million tons. However, there are two more important factors to consider: first, America is not a static industrial nation and the 77 million product tons of ferrous materials produced last year will be dwarfed in some period still ahead, and second, when a new engineering material emerges from the mind of man and fits the pocket book of the ultimate consumer, new horizons are established for industrial America.

When steel, synthetic rubber, shatterproof glass, plastics, aluminium, magnesium and a host of other engineering materials became available, they did not replace the older materials—they opened up new horizons of opportunity and, most generally, carried the use levels of the older materials still higher. Of course, competition of materials and industries became keener, but the size of the industrial pie grew at a faster pace.

These figures translated to British outputs should be divided by some figure a little under five. The figure of 1½ million tons increase in foundry output therefore becomes 300,000 tons in British practice—a very substantial amount.

It is not proposed to pass any opinion on these figures, but to leave readers to digest them—if they can. In spite of all exaggerations there is no doubt that the development of "as-cast" nodular irons is one of the biggest steps forward ever offered to the foundry industry, and it should be seized upon quickly in this country so that we are not left to lag along behind the United States, as has happened in a few previous instances—the original discovery was British!

The Author is very anxious that nothing he is to say shall be taken as derogatory to nodular irons, but he maintains that this is a specialised field and he desires to examine the problems that face the ordinary grey-iron founder, to whom the nodular experts are now graciously leaving their own field. What are these problems from the metallurgical angle?

Phosphorus

First there is phosphorus—an element which has hardly got a friend in the iron-foundry world, although it is realised that from a wear-resistance point of view it probably has many advantages. It should not be forgotten that it is was intentionally introduced into bronze for wear resistance, and that in cast iron its function is similar. But there is no doubt that the presence of phosphorus is very harmful as regards porosity, and the appearance of a porous area in a wearing surface outweighs the advantage of the presence of phosphorus in other parts. It is also a serious embrittling element. Moreover, low-phosphorus iron ore is practically worked out in Britain and Central Europe, and all low-phosphorus foundry irons must be paid for by exports. Cannot foundrymen find a way either to eliminate phosphorus or neutralise its harmful effects? The steel industry has found a way to eliminate it and this has helped the iron-foundry industry which has developed the technique of remelting steel scrap in large proportions, but this technique has its obvious limitations. A personal suggestion is that future development may not necessarily be along the lines of elimination of phosphorus, but of harnessing phosphorus so that it no longer is harmful. Just think what might be the position of cast iron if manganese had not been naturally associated with iron, all ready to counteract the harmful chilling influences of sulphur. If this had not been the case, cast iron would probably have been limited to applications which did not involve machining and by now would have been relegated to the limbo of forgotten things. Cannot the same be done for phosphorus? Have British foundrymen been too long led by American practice where a high-phosphorus iron is one that contains 0.3 per cent. so that little or no problem arises? It is deemed that mastery of the phosphorus difficulty is No. 1 problem facing the iron-foundry industry.

Porosity and Shrinkage

The second problem is that of porosity with its twin but opposing brother, shrinkage. The work of Timmins' at the British Cast Iron Research Association has shed much light on this problem, but much remains to be done. A great majority of the research and development in the last 30 years has been towards producing a sounder cast iron, and the increase in strength, referred to earlier, is largely incidental in this improvement. But this has brought along with it an iron with a much greater shrinkage in changing from liquid to solid, necessitating much more elaborate running and feeding arrangements, with the consequent necessity for melting far more metal to produce the same amount of castings. Is not the liability of cast iron to have internal porous or shrinkage defects one of the reasons why its use is not spread over a much wider field than at present?

Take the example of pipes. The standard minimum thickness for Class B 6-in. diam. pipes for use at 400-ft. head pressure is 0.38 in., but if these are made as spun pipes, spun in sand from the same metal, the standard thickness is reduced to 0.284 in., a reduction of 25 per cent. merely by adopting a process which ensures a thoroughly sound casting.

Examining for a moment a literal aspect of the title "Where is Cast Iron Going To?"—Table VI

TABLE VI.—*Iron Balance Sheet (Based on Statistics Published in the Council of Ironfoundry Associations' Annual Report, 1948).*

Production (in thousands of tons).	High phosphorus.	Low phosphorus.
Automobile		178
Building and domestic	467	
Cast iron pipes	502	
Ingot moulds		318
Railway equipment	278	58
Engineering and jobbing	1,012	502
Malleable		131
Totals	2,259	1,187
	3,446	

Consumption (in thousands of tons).	High phosphorus.	Low phosphorus.
Foundry iron	1,375	200
Hematite		489
Pig iron for malleable		82
Refined and cylinder		135
Steel scrap		213
Hematite ingot-mould scrap		68
Cast iron scrap	884	
	2,259	1,187
	3,446	

NOTES —(1) Production includes 5 per cent. added to statistical figures to allow for melting losses.
(2) Low phosphorus includes materials under, say, 0.4 per cent. P.
(3) Cast iron is scrap arrived at by difference; the statistical figure includes shop scrap remelted.

Where is Cast Iron Going To?

shows the production as given in the Council of Iron-foundry Associations' annual report for 1948, balanced with the raw materials used. From this it will be seen that, if the specialised products of ingot moulds and malleable are excluded, just over 50 per cent. of the castings produced are classed as engineering and jobbing and only about 6 per cent. automobile, the balance being concerned with pipes, building and domestic, and railway castings (mainly chairs). From the amount of low-phosphorus iron consumed by the engineering and jobbing industry, it may be either that the average phosphorus in engineering castings is just under 1 per cent., or that one third of these castings are low-phosphorus and in the high-strength category and the remainder in very-high-phosphorus iron. The truth lies between these two extremes, but it is a personal opinion that only a very small proportion of this 1½ million tons is in low-phosphorus iron from the point of view of strength and that what low-phosphorus materials are used are almost entirely used from the point of view of soundness.

If development could be such that it is possible to obtain 100 per cent. sound castings, with or without the elimination of neutralisation of phosphorus, general engineering castings would use very little high-strength iron.

It is not within the Author's province to say on what lines these developments should follow, and he can only indicate what, in his opinion, is desirable. He would, however, suggest that greater attention be paid to the production of irons of higher carbon than are at present fashionable. Dr. Angus[10] and others have drawn attention to the importance of knowledge and control of the carbon equivalent (total carbon plus one third of the silicon and phosphorus) and it is possible that, if foundrymen can learn to control carbon much more accurately than they do at present, and obtain a much clearer picture of the effect of other elements and cooling rates on the eutectic carbon amount, the solution may come along these lines. The pendulum has, as a personal belief, swung too far in the direction of low carbon, and it may be necessary to study how to obtain regularly irons with a carbon equivalent value of 4.3 or over. For example, Dr. Angus has recently shown[11] that to avoid cracking in light castings the carbon equivalent value should be about 4.6.

Markets

Finally, there remain two more problems—both psychological. First, have foundrymen yet thrown off the mentality brought about by 10 years of good markets and raw material shortages? Are they not content just to make a mould and fill it with anything that contains iron? For years now they have had to accept types of pig-iron and scrap that they would not have given storage space to before the war. The pig-iron makers are gradually coming back to a more reasonable attitude in the supply of pig-iron, but the silicon ranges offered are usually too wide and very few suppliers seem to have heard of "total carbon." The buying of pig-iron without reference either to fracture or total carbon is to be deplored. Also, the introduction of the large-hearth blast furnace, worked at high speed on lean ores, fortified by "bedsteads," has produced an iron that is, undoubtedly, more difficult for the foundry industry to use. Foundrymen must wake up and make their requirements known. Cupola coke quality has also suffered and, although efforts are being made to improve it, it is doubtful whether the industry will ever have quite the same quality of coke again and it may have to adapt its cupola practice to suit the modern coke.

Prestige

The second psychological point is with regard to the material itself. Do not too many foundrymen look upon cast iron as something to be ashamed of? The Author was personally brought up with a jolt on this point when a friend said of a child who was very destructive of his toys. "We shall have to have all his toys in cast iron in future." My first mental reaction was, "What—in that brittle material?" It is, of course, a brittle material by some standards, but, in its own field it reigns supreme. During this Paper quotations have been given from remarks made by enthusiastic Americans; the following reads quite differently:—

> A considerable proportion of the pig-iron which is annually produced is used by the iron-founder for the purposes of his art. The application of cast iron for this purpose in England dates from the reign of Elizabeth, since which period iron founding has steadily gained in volume and importance. It has been sometimes suggested that cast iron was in danger of being superseded by wrought iron or steel, and though since about 1850 the use of cast iron has been gradually abandoned for constructive purposes, so many other applications have been found for this material that the art of the founder is in no danger of extinction or even of serious diminution. Cast iron is the cheapest and most abundant form in which the metal is met with in commerce. It is fusible at a temperature which can be readily attained, and as it receives remarkably exact and clean impressions of a mould, it can be cheaply produced, even in very intricate forms. Being protected by a skin, cast iron resists atmospheric influences better than either wrought iron or steel, while for the wearing surfaces of machinery nothing is superior to cast iron on cast iron so long as sufficient area is provided.

This was written by Professor Turner in his book "The Metallurgy of Iron" in 1895. Is it not just as true of the position to-day? When foundrymen improve their product they should not run away from the name and christen it with some fancy ". . . ite." Let the industry be proud of its material—remember the everyday saying for something which can be relied upon is "A cast-iron certainty."

Acknowledgment

In conclusion the Author wishes to acknowledge the very valuable help received from the British Cast Iron Research Association, particularly Mr. Morrogh, in the supply of samples, experimental results and lantern slides, also the assistance of several friends, Mr. Tomkin, Mr. Morgan and Dr. Everest for material, data and slides.

Finally, his thanks are given to the staff of S. Russell & Sons, Limited, particularly Mr. Toach, for carrying out much of the experimental work, and to his co-directors for permission to do the work and publish the results.

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DISCUSSION—LANCASHIRE BRANCH

Vote of Thanks

MR. C. R. VAN DER BEN said they had all expected something interesting when they came to hear Mr. Russell speak, and they had not been disappointed, because the production of nodular irons had been dealt with at considerable length. The pith of the lecture lay in that part of it which dealt with materials which were normally available economically. It was certainly very important to find some method to make the use of higher-phosphorus irons a better proposition. Also, the question of carbon equivalents was important.

He felt that perhaps, of late years, somewhat undue stress had been laid upon high-duty irons to the neglect of ordinary grey irons which, after all, at a rough guess, did constitute at least 95 per cent. of the total output of iron castings. Mr. Russell had certainly given them all something to think about, and he had very great pleasure in moving that a hearty vote of thanks be accorded to him for doing so.

MR. F. W. NIELD seconded the vote of thanks, remarking that it was important to know the part that nodular iron was going to play in the engineering industry. Even if it did not come up to a desirable standard at the moment, nevertheless there was a chance for further research to take place.

The vote of thanks was carried unanimously by acclamation.

MR. RUSSELL, in responding to the vote of thanks, said that the first time he visited the Lancashire branch he had spoken about special irons. Mr. Arthur Sutcliffe had brought a piece of casting and asked would his (Mr. Russell's) alloys make it any better, and the question had rather upset him. He had thought since as to whether Mr. Sutcliffe was not right in putting his question; possibly too much thought had been devoted to irons for special purposes. If all castings could be made 100 per cent. sound then foundrymen could forget everything else.

MR. E. LONGDEN pointed out the very great service Mr. Russell had rendered to the industry of the country by directing attention to the desirability of using high-phosphorus irons and to the economics of using the country's own raw materials. He recalled that a Mr. Wheeler, speaking at a Lancashire branch meeting long ago, mentioned the usefulness of phosphorus in liner iron and stated that such a class of iron wore much better than the all-pearlitic of the very-low-phosphorus material. This had also been proved to be the case years ago with respect to cast-iron bearings. Founders had been accustomed to cast these bearings with phosphorus round about 1.1 to 1.2 per cent., and they had had a very long life and there had been no complaints. When a specification had been sent forward that these bearings must in future be kept to 0.4 per cent. phosphorus, in due course they failed in a matter of hours.

The point about the phosphorus in the liner was that it had a uniform section. If the elements and freezing rate could be adjusted so that there was a fairly rapid rate, then an absence of porosity could be secured. There was need for further study in regard to the effects of phosphorus. Years ago the old-time foundryman judged the metal by fracture and by mechanical tests, but nowadays the structure of cast iron was examined much more carefully.

Shock Resistance

MR. GALE asked, with respect to nodular iron, had Mr. Russell any experience of shock resistance? For some time, he had regarded nodular iron as being a serious competitor to the malleable type. A series of tests had been conducted, and castings had been made which gave somewhat equivalent tensile and elongation to the malleable type which his firm was producing, a cold bend of 90 deg. was obtained quite easily without fracture.

The castings were then submitted to the customer, who found that the machineability was quite as good as with the blackheart malleable. Then when he came to his final tests he clipped the casting in a vice, banged it with a 28 lb. sledge hammer, and it broke. The malleable type did not break but became bent instead.

On the question of carbon equivalent, he would like to ask as to the use of the ordinary grey irons with phophorus 0.8 or 0.9 per cent. Would Mr. Russell use a carbon equivalent or just over 4.3, or just below 4.3, in order to ensure freedom from porosity?

MR. RUSSELL, referring to shock resistance, did not wish to make his lecture too long by bringing in a lot of facts which had been fairly well publicised. So far as he was aware no really suitable shock test had been devised. It did not seem to be good enough material to use the ordinary Izod test-piece designed for steel. Although there had been a very great deal of research work done the data were difficult to rationalise.

In comparing malleable with nodular iron, the nodular structure persisted right through to the skin, whereas in the case of malleable iron there was a skin effect and this must have considerable influence upon shock resistance. There was also the question of the silicon in the ferritic metal; magnesium nodular iron had about 1½ per cent. of silicon whereas the average malleable was 0.4 per cent. The consideration of the carbon equivalent for 0.8 to 1.0 per cent. phosphorus iron would involve another lecture, but there was no doubt it had to be lower, and the present idea was that the lower it was the better.

MR. C. C. HODGSON, referring to silico-ferrite, said that Mr. Russell had said that silico-ferrite was a weaker material. In what sense did he use the term "weaker"? Did he mean it in a tensile sense or an impact sense? If it was weaker in the tensile sense then he would not agree with Mr. Russell's statement.

Had Mr. Russell noticed the inclusions when examining sections of nodular iron. There was a very light-coloured watery inclusion in magnesium-treated iron.

Impact Tests

To deal with impact, he understood from the Izod tests which had been carried out that there was considerable variation with whiteheart and blackheart malleable and the nodular irons. The best of them had been as good as the blackheart malleable, but the best of them had not been anywhere nearly as good as the whiteheart malleable.

Dealing with the subject as to whether better use could not be made of home-produced phosphorus iron, perhaps at first sight this might appear to be asking too much. However, work had been done, mainly by British initiative, on graphite during the past 10 years and he supposed that if any of them had been asked 10 years ago if nodular iron could be made "as cast," they would have said it was impossible.

MR. RUSSELL explained that he had used the term "weaker" in a very loose sense. He really meant it from the point of view of ductility and impact. It was well known that, as the silicon content increased, then the ferrite became more brittle and more rigid. He thought Mr. Hodgson knew a great deal more about nodular iron than he did. He could not throw any light on the identity of the inclusions mentioned.

MR. E. LONGDEN said that with regard to the feeding of nodular cast iron, the bronze, malleable-iron, and

Where is Cast Iron Going To?

steel founders had much more serious problems of fluid shrinkage to solve. When they were told of a two- or three-lb. casting and 28 lb. of metal being required to produce it, then he thought the matter ought to be placed in the hands of some elementary founder in steel or malleable cast iron.

MR. RUSSELL said he had referred to the finished machined weight of the component.

MR. HAYNES thought they could not afford to experiment with test-bars; they must give the right casting to the customer. There had been lamp posts which had been in use for nearly 100 years, and they would withstand a test quite as well as some of the irons which were produced at the present time. A piece of cast iron which had been in use for 100 years had been sent for research purposes and 12 saws were broken before it could be cut through. It was found that its centre was even stronger than the outside.

He had been asked to cast a high-grade crank-shaft, six inches in diameter on the journals. When he saw that the title of the Paper was " Where is Cast Iron Going To?," he had hoped to receive some information as to whether nodular iron should be used. He had thought he would be able to get some information whether to run it on its end or on its flat, whether to put risers on the journals, whether to run it in 40 or 60 sec., and whether to run it by ingates on the side or the top or the bottom.

He had read so much about nodular iron in the Press that he had thought the matter was now settled commercially. Personally, he did not think they had gone far enough with the irons they had got. When scientists could say how to make irons without porosity with the materials available at the present time, the information would be welcome.

MR. RUSSELL said that Mr. Haynes had fully understood his point, namely, that they had not got far enough with the irons that were available, let them stick to that.

Quality of Old Castings

MR. HAYNES mentioned also that if it had not been for the cast-iron pillars erected in Manchester there would have been many more lives lost during the blitz. Steel girders were twisted so that they presented a worm-like appearance. Some of the cast-iron pillars had been made 100 yrs. ago. He had dug up a six-inch pipe which he had been unable to break and it must have been underground for more than 100 years; such pipes seemed to grow stronger with age. This caused him to wonder whether the castings made nowadays were used too quickly.

MR. RUSSELL remarked that Mr. Haynes was really dealing with internal stresses. There was not the slightest doubt that an old casting would stand up much better than a new one. It did improve, though he did not think it required 100-years time in order to do so. He had some evidence that it could be improved by treatment for three hours at 500 deg. C.

MR. VAN DER BEN considered it should be borne in mind, with respect to old castings, that many old irons were produced from different raw materials and by a different practice. That was a point that perhaps Mr. Russell would not like to admit. He had had the good fortune, some years ago, of receiving cast-iron turnings from a bridge at Newcastle and the sulphur content was 0.55 per cent.

MR. D. FLEMING agreed with Mr. Russell and Mr. Longden that structure was an important factor. In a number of cases he had investigated, he had found that structure was due to the practice of the blast-furnace operator as well as to the constituents of the iron itself. Did Mr. Russell regard structure as being something entirely independent from analysis, or whether it was due to inefficiency in the analytical determination.

He considered that founders should be more concerned with the solving of the various problems which arose than they appeared to be. Common high-phosphoric irons and their soundness was a direct contradiction of the requirements that might be thought necessary for some of the other castings which were required entirely free from cracking. It all crystallised down to the points stressed by Mr. Russell, Mr. Haynes, Mr. van der Ben and Mr. Longden. There was a crying need for further research work in regard to common irons; there was not half enough known about them.

Inexplicable Variations

MR. RUSSELL said that there were variations in structure of cast iron which could not be explained by analysing for the usual elements only. Whether the variations were due to some element not normally detected, or whether they were due to some physical property, was a question not yet solved. He entertained considerable doubt with respect to the question of change-over from sand-cast to machine-cast pig-iron. He had an idea—it might be called superstition—that if the graphite flake in pig-iron was ½-in. long when it went into the cupola, that it would produce a coarser cast iron than if it was ¼-in. long. Up to the present, he had fought against the idea and considered it did not matter. He still thought it did not matter as long as it was understood how they were to arrive at a solution of the problem by analysis. The quickest way would seem to be to have a sand-cast sample of a chill-cast pig.

The other points which had been raised really supported what he had said previously. The use of a high carbon-equivalent in order to prevent cracking was important. The present state of knowledge of carbon-equivalents was dangerous, and there should be more fundamental research on the structural diagram of cast iron in order to ascertain what were the eutectic points for various compositions and what was the effect of the cooling rates. Was 4.3 the right figure?

MR. E. LONGDEN remarked that the varied results obtained with cast iron were certainly becoming more clearly understood than they had been in the past, particularly in respect to the difference between a sand-cast pig and one made in a metal mould. Considerable investigation was taking place at the present time in respect to steel castings. The influence on the casting of mould conditions was so marked that it persisted even after annealing. Fractures in service could definitely be traced to the original crystal formation which could not possibly be disclosed by radiography.

MR. D. FLEMING wished to make one point clear. When he had addressed a question to Mr. Russell with respect to fracture and analysis he was thinking entirely in terms of the raw material going into the cupola. He would be the first to admit that the conditions thereafter varied considerably.

MR. RUSSELL fully appreciated the point of what happened to the cast iron after it was put into the cupola, but he was trying to keep the subject-matter of his Paper to pure metallurgical research. The research work which had been done with respect to sands and cupolas had been of great assistance to the ordinary cast iron founding industry, but the point he was making was that it had not helped so much metallurgically.

MR. VAN DER BEN mentioned an example from his experience with the question of graphite size. Some years ago, he had carried out experiments, using a very small cupola. Two lots of material were prepared, both from the same metal, one of which was chilled; one was white and the other was grey iron. Upon re-melting the two materials there was no difference to be detected in their properties.

DISCUSSION—EAST MIDLANDS BRANCH

MR. LILLYMAN asked the Author whether nodular iron was difficult to produce, that was, to obtain the correct characteristics of the metal.

MR. RUSSELL, in reply, said he had stated that it was very difficult to assess the exact amount of addition required. What little experimental work he had carried out was not very successful but he had no doubt this iron was being produced in bulk in the States. There was a quantity of literature on the subject, and one firm claimed a daily production of 50 tons of nodular iron. The consistency of raw material was one of the prime necessities. He thought there was a great deal of difficulty in production to ensure that the structure was properly nodular through the various sections.

MR. LILLYMAN said he had heard that the inoculation of nickel-magnesium caused the temperature to decrease rapidly.

MR. RUSSELL said he was unaware of this feature.

Replacement of Forgings

MR. SADLER speaking as a visitor and also representing the users of a wide variety of various types of castings, said he had enjoyed the lecture and had learned much. Some 12 months ago there was an item one night produced by the B.B.C. on the progress of cast iron. The following morning he was asked why his works were not using this new iron. He had to confess his ignorance, but after making enquiries he found it was not suitable for acceptance for regular deliveries at that time.

His firm used a considerable number of forgings, as well as non-ferrous, iron and steel castings. The position with forgings has been very difficult, especially from the point of view of delivery and also the cost for relatively small quantities. His colleagues had considered at times an alteration to eliminate the need for expensive dies and he was now wondering whether there was in his particular case some possibility of using nodular irons if they had the necessary strength. Sometimes he was able to change from forgings to Ni-Tensyl castings, but in other cases the material was not satisfactory from the point of view of lack of ductility.

MR. RUSSELL, in reply, said nodular iron could replace forgings and the applications lay in such a field. Moreover, if he were a malleable founder he would be very interested. There was the possibility of producing an iron nearly as good as malleable but in very much greater section thicknesses. There were limitations, however, and in many cases the malleable founder and the steel founder would not be satisfied with its properties. Foundrymen had a long way to go, but compared with cast iron the new material was as different as chalk from cheese.

MR. BUTTERS said the lecture had been delivered at a very opportune time, as there were, he thought, three companies in the country which were attempting to produce nodular iron on a commercial basis at a rate sufficient to supply the trade. One of the points, however, which was rather unsettling, was that it would be difficult to inoculate to achieve soundness in a wide variation of section. This was understandable as the proper reaction was so delicately balanced. His firm had already placed an order for some magnesium-treated nodular-iron castings and had delivery of six, but he personally was not aware they gave inconsistency in structure. He was also intrigued by the prospect of commercial sales in competition with steel or malleable, but noted the very low yield from such castings due to the very high proportion of feeders. He was given to understand that the pattern equipment for steel could be applied for this type of iron, and did not involve a lot of alteration in technique. He also understood the price was competitive with malleable in spite of the low yield. Low sulphur essential for this particular iron, could be obtained from a high-duty iron exceptionally low in sulphur, as the magnesium would take care of part of the sulphur. The use of a basic-lined cupola would also provide low-sulphur iron.

MR. RUSSELL hoped he had not made a *faux pas* as to varying sectional thicknesses. He had been influenced by the published literature which admitted varying structures from three different members of one casting. All he had said was that makers would have to overcome the trouble. In the particular castings illustrated he had produced 1.26 in. bars and cylinders from the same iron, and had to make minor adjustments in the amount of addition between the 1.26 in. bar and $\frac{5}{8}$ in. cylinder. As to yield and Mr. Butters' remark that the steel foundry could use practically normal procedure, he pointed out that he had stated that the amount of feeding used for malleable might be too much. He was only quoting from literature and not from experience. If not as much feeding were necessary for nodular iron as malleable it should be possible to produce this iron to compete with malleable. The cost was wrapped up with the amount of sulphur to be removed. It could be produced from iron of any sort, but one used the magnesium primarily to desulphurise. The potentialities of the basic-lined cupola were obvious and the Author drew attention to the worth of basic-lined ladles.

MR. J. D. HILL said he had no personal experience with the production of nodular iron, but he understood from published literature that with the cerium treatment processes it was necessary to have an iron of hypereutectic composition. Was he right in assuming that, with the magnesium treatment, iron of practically any analysis could be treated? Mr. Russell referred to the phosphorus question, and stated that the steel makers had overcome the phosphorus trouble by using basic-lined furnaces. Was there any future in the basic-lined furnace for materially reducing the phosphorus in the iron-founding industry?

To conform with the carbon equivalent did Mr. Russell advocate the raising of the total-carbon content in cast iron? While the liquid shrinkage of cast iron was generally reduced as the eutectic value was approached, as the eutectic value decreased shrinkage increased.

MR. RUSSELL agreed that founders should use a very high carbon for the cerium nodular processes, but with the magnesium process much lower carbons could be used. As to the use of basic-linings to reduce the phosphorus in cast iron, he pointed out that before this was possible, the silicon had to be removed. In experiments on basic-lined cupolas there was some slight reduction in phosphorus in low-silicon iron. The point he wished to stress was must it be eliminated, or was it possible to circumvent the baleful influence?

He agreed wholeheartedly with the remarks made by Mr. Hill on carbon equivalent. Following all the research and development it had been found that by reducing carbon equivalent there was more consistency through increasing thickness and stronger, and, more important, sounder iron was forthcoming. Possibly, however, foundrymen could get away from that view in their approach to the problem, or if they knew more about carbon equivalent could they not use it better? He still believed that foundrymen went too far in using low carbon. If castings were 100 per cent. sound it did not matter if they were only 5 tons per sq. in. tensile. He thought technicians were over impressed with the idea of tensile strength.

Institute Elects New Members

At a meeting of the Council of the Institute of British Foundrymen, held at the Palace Hotel, Buxton, on June 6, the following were elected to the various grades of membership.

1st LIST

As Subscribing Firm Member

Dowson & Dobson, Limited, general engineering merchants and contractors, 29, Webber Street, Selby, Johannesburg, South Africa.

As Members

W. E. Benson-Armer, mechanical engineer, Dowson & Dobson, Limited, Johannesburg; J. A. de Kiewiet, foundry owner, Climax Brass and Aluminium Foundry, Village Deep, Johannesburg, South Africa; J. J. Ferguson, foundry superintendent, African Malleable Foundries, Benoni, South Africa; Franz Flubacher, foundry manager, Britannia Iron & Steel Works, Limited, Bedford (representative: Britannia Iron & Steel Works, Limited); G. T. Reid, foreman, North Western section, British Railways, Newcastle; K. Schedivetz, foundry manager, Gearing & Jameson, Limited, Capetown, South Africa; *R. F. Coates, foundry ratefixer, Ransomes & Rapier, Limited, Ipswich; *L. Johnson, chief assistant metallurgist, Head, Wrightson & Company, Limited, Thornaby-on-Tees; *R. L. Simpson, assistant foundry manager, Modern Foundries, Limited, Halifax.

As Associate Members

C. Britten, moulder, High Duty Alloys, Limited, Slough; L. R. Khalil, chief inspector, Carriage and Foundry Works, mechanical department, Egyptian State Railway; W. A. Reid, A.I.M., works metallurgist, Wm. Mills, Limited, Wednesbury; L. Worsnop, assistant foundry foreman, Glover & Wood, Limited, Bradford.

As Associates (over 21)

G. W. Micklewright, assistant metallurgist, Idoson Motor Cylinder Company, Limited, Smethwick; G. S. Ubhey, assistant foreman, P.W.D. Irrigation branch, Punjab, India.

As Associates (under 21)

W. G. Aspell, machine-tool mechanical apprentice, Alfred Herbert, Limited, Edgwick, Coventry; S. Benson, technical assistant, English Electric Company, Limited, Bradford; W. B. Hetherington, draughtsman, J. Fowler & Company (Leeds), Limited, Doncaster; N. Reid, laboratory assistant, Jarrow Metal Industries, Limited, Jarrow; P. Robertshaw, apprentice iron moulder, Denham's Engineering Company, Limited, Halifax.

2nd LIST

As Subscribing Firm Member

The research laboratories of the General Electric Company, Limited, Wembley.

As Members

M. C. Caplan, works metallurgist, research laboratories of the General Electric Company, Limited, Wembley; S. B. Horsman, director, J. C. Mackinlay & Company, Limited, Mitcham; J. M. Houliston, foundry manager, British Northrop Loom Company, Limited, Blackburn; R. G. Pare, foundry manager, Barnard & Sons, Limited, Barking; D. M. Poulter (Mrs.), director, Storey Foundry Company, Limited, Stockport; F. K. Vickery, foundry manager, Brecknell Willis & Company, Limited, Chard; R. H. C. Weeks, foundry technician, Fordath Engineering Company, Limited, West Bromwich; *F. George, director, Zirconal, Limited, Sydenham, London, S.E.26; *P. B. Lake, director and secretary, Lake & Elliot, Limited, Braintree; A. J. Nicol Smith, B.SC., senior experimental officer, Ministry of Supply, London, W.C.2.

As Associate Members

C. E. Ball, foundry foreman, Metropolitan-Vickers Electrical Company, Limited, Manchester; Tom Clark, L.I.M., foundry metallurgist, Leyland Motors, Limited, Leyland; K. Fabian, castings inspector, Dialoy, Limited, Cardiff; L. Locke, representative, Harborough Construction Company, Limited, Leicester; C. C. McKinnon, general manager, Conrad Parlanti Castings, Herne Bay; J. Seddon, patternshop foreman, John Hall & Son (Oldham), Limited, Oldham; W. D. Slinn, planning engineer, David Brown-Jackson, Limited, Salford, 5; J. S. Smith, foreman moulder, Kent Alloys, Limited, Strood; W. F. Trevis, assistant foundry manager, Belling & Company, Limited, Enfield; S. Ward, foundry planner, A.P.V. Company, Limited, London, S.W.18; B. H. Williams, steel converter superintendent, Partridge Jones & John Paton, Limited, Risca; Alec Yates, senior metallurgist, Newman Industries, Limited, Bristol; *A. Brookfield, foundry manager, Davies & Metcalfe, Limited, Stockport.

As Associates (over 21)

G. A. Alves, apprentice engineer, Wm. Jessop & Company, Limited, Southern India; J. P. Atherton, patternmaker, David Brown-Jackson, Limited, Salford; E. Brandley, iron moulder, E. Pass & Company, Limited, Denton; J. W. Crompton, moulder, Safranco, Limited, Johannesburg, South Africa; G. A. Dew, assistant metallurgist, Qualcast (Ealing Park), Limited, London, W.5; S. S. Gupta, student engineering apprentice, Foundry Equipment, Limited, Beds.

BRADLEY & FOSTER, LIMITED, of Darlaston Iron Works, Darlaston, Staffs, have formed a new company, Bradleys (Darlaston), Limited, whose registered office is Darlaston Ironworks, Darlaston (telephone Darlaston 353), for the purpose of acquiring the business in metallic abrasives, round shot and angular grit, now carried on by this company. The new company commenced trading on July 1, and all unexecuted orders for round shot and angular grit on July 1 have been transferred to Bradleys (Darlaston), Limited, and all deliveries from this date are being invoiced in their name.

Modernising a Gear Foundry

Major Alterations at a Salford Works

STRUCTURAL ALTERATIONS and extensions at the century-old foundry and gear-manufacturing works of David Brown-Jackson, Limited, now nearing completion, afford an interesting study of works engineering under the difficulties of carrying out major schemes with the minimum disruption of production. The foundry, built in 1840, was awkward in shape, being long and comparatively narrow and having the additional handicap to efficient handling of being bounded on the long side by the Manchester-Bolton-Bury Canal. Two roads and a railway line prevent development on the other three sides, and therefore the re-organisation work affecting the foundry concentrated on the full utilisation of moulding-floor space achieved by rationalised mechanical handling of materials and products. These two means were interdependent. Fig. 1 presents in axonometric projection a view of canal-side developments which shows the changes described.

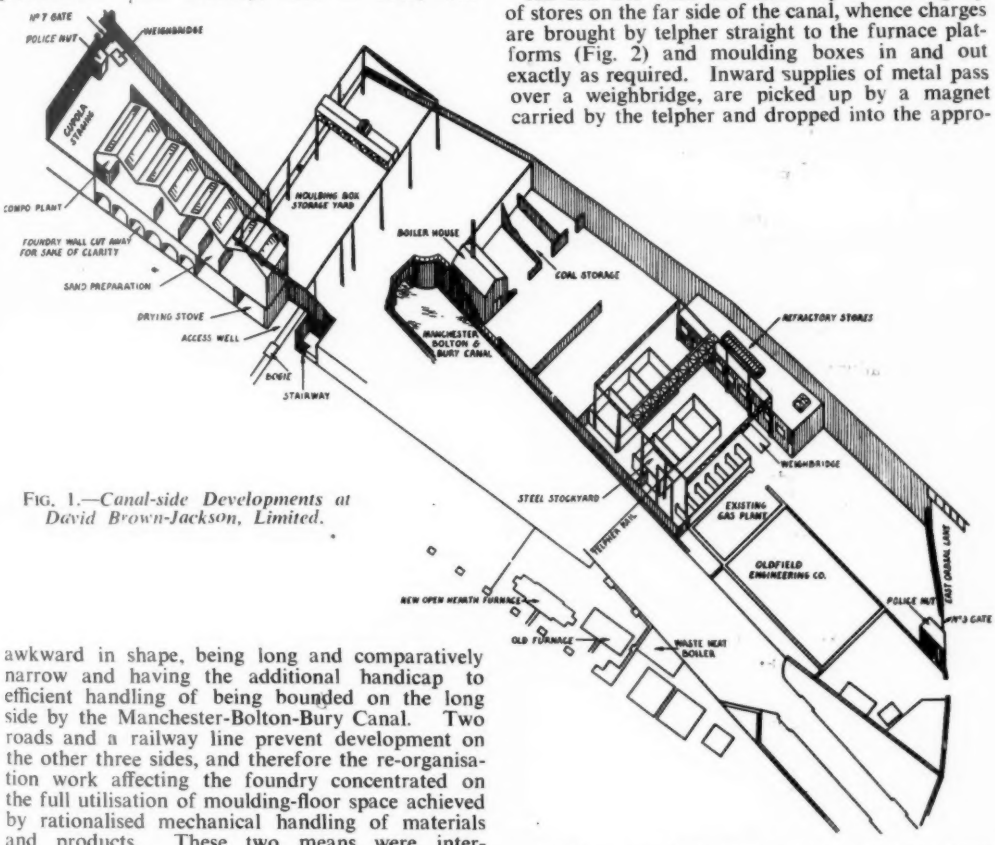


FIG. 1.—*Canal-side Developments at David Brown-Jackson, Limited.*

Metal and Moulding-box Stores

Formerly, metal supplies were drawn from stores established on the far side of one of the adjacent roads and had to be carted into the foundry by motor wagon as and when required, a proceeding that not only entailed an expensive double handling of materials but often created transport difficulties. Moulding-box disposal was another handicap, for their passage through a long foundry with limited ports to the outside was far from easy and there was always a suspicion that this drawback was taken as an excuse against their removal after use.

All this has been eliminated by the setting up of stores on the far side of the canal, whence charges are brought by telpher straight to the furnace platforms (Fig. 2) and moulding boxes in and out exactly as required. Inward supplies of metal pass over a weighbridge, are picked up by a magnet carried by the telpher and dropped into the appropriate bin. Each charge is made up in 6-ton boxes and carried over the canal. The chance of failure to bring metal to the furnaces on time is eliminated, the metal is easier to handle, and there is no disruption of other foundry movement.

The moulding-box store bridges the canal and is opposite the moulding shops. The carriage of boxes from storage into use is by overhead travelling crane, the boxes being delivered to a 10-ft. access well, built into the side of the moulding shops, and from there moved to the exact site by

FIG. 2.—*Telpher for Feeding the Furnace Platforms.*

FIG. 3.—*General View of the New Machine Shop.*

overhead crane. In summation, this scheme has effected a substantial reclamation of floor area, for the night shifts have simple means at their command for clearing the floors of used boxes and the day shifts are thereby presented with a clear floor on which to work.

Sand-preparation Plant

Just as the position of the furnaces and the moulding floors fixed the trans-canal sites for metal and box storage, so this modified flow-system dictated the position of the sand-preparation plant. Incoming deliveries of sand and other raw materials

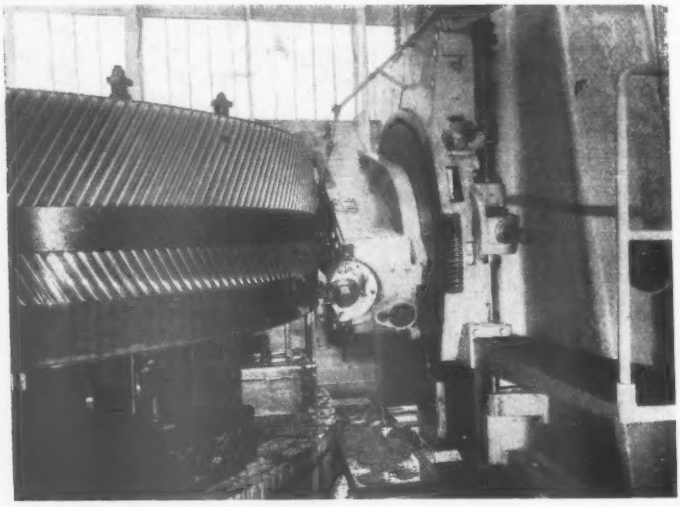


FIG. 4.—*Hobbing the Teeth of a Large Winder Wheel for South Africa.*

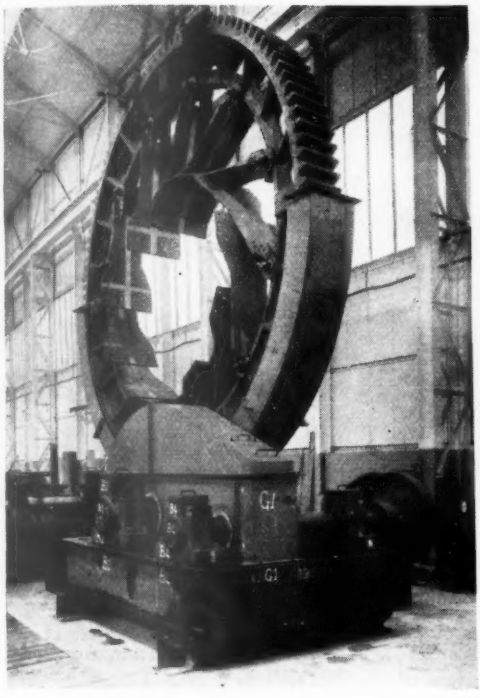


FIG. 5.—*Gear Drive for Cement Mill.*

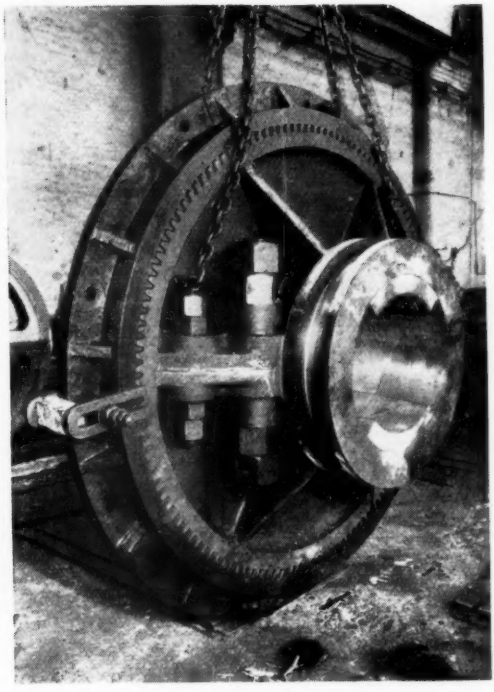


FIG. 6.—*Spur Clutch for a Winder Gear.*

are unloaded down a shute into bins inside a new building devoted to sand-preparation, which houses also three sand mills situate on foundry floor level. The desired mixings are fed into each mill from the top-level bins and are discharged through disintegrators attached to the discharge doors. The mills have water-sealed lids to prevent dust pollution of surrounding areas. A considerable amount of moulding sand is reclaimed by passing it over a rotary sieve and finally conveying it over a magnetic separator to trap metallic particles and tramp iron.

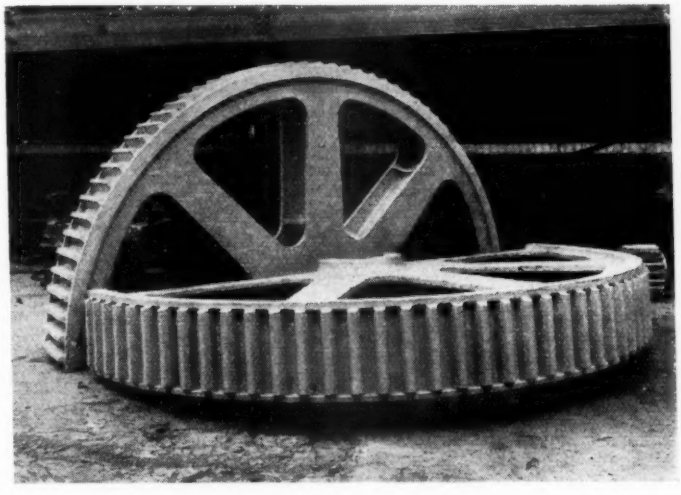


FIG. 7.—*Machine-moulded Spur Gear for Sugar-processing Machinery.*

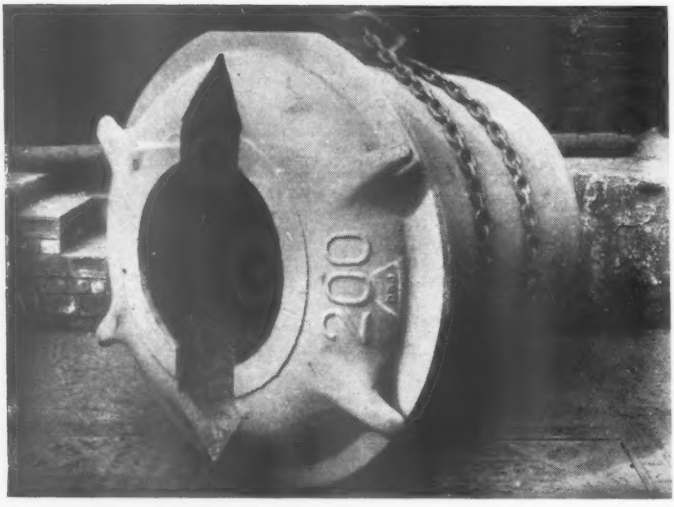


FIG. 8.—*Cast-steel Melting Pot for Non-ferrous Alloys, weight 6 tons.*

A fully-mechanised gas-producer plant on the far side of the canal serves two open-hearth melting furnaces, a battery of mould-drying stoves and an annealing stove for heat treatment, all operating simultaneously.

Machine Shop

The chief part of the extensions scheme to provide more machine-shop capacity centres around the erection of a new building to house the heavier part of the firm's gear-cutting plant. This single-span building is 280 ft. long by 64 ft. wide and is 65 ft. to the apex, served by a 35-ton 4-motor crane. As in the older shops, careful attention has been paid to lighting. Fig. 3, a photograph of part of the interior taken on a dull March morning, demonstrates the excellence of the natural lighting proceeding from continuous windows running the lengths of both sides and set sufficiently high to prevent glare. Artificial lighting is by 78 overhead lamps of 58½ kw. loading, half of them of the tungsten-filament type and the remainder mercury-vapour lamps to give a reasonable approximation in light-colour to daylight and a bench reading of 25 ft.-candles. The firm attaches prime importance to the quality of lighting in this shop, some of whose products are shown in Figs. 4 and 5.

Throughout the works, in fact, light intensity values are substantially in excess of those normally deemed sufficient. An older, heavy machine shop, for example, which it has not been found practicable to improve structurally, has a reading of 20 ft.-candles. The winder gear spur clutch of 7 ft. P.L. dia. shown in Fig. 6 is typical of the work produced there.

The foundry also is notable for the efficiency of its lighting, which ranges from 6 ft.-candles on the furnace charging platform to 12 ft.-candles in the core shop. On the moulding floors, it has been found desirable to cut down the general illumination and boost up local lighting, some of it supplied by adjustable lamps. Fig. 7 shows the two halves of a 13½-ton machine-moulded spur wheel for sugar processing machinery, made and delivered in 16 days, as an example of the production from one section of the moulding floor, and Fig. 8 shows a cast-steel crucible weighing 6 tons for the melting of non-ferrous alloys as a typical product of another section.

Aachen Foundry Conference

There is to be held at the Aachen Foundry Institute on July 13 and 14, a meeting at which foundry layout, equipment, and machinery will be discussed. The following programme has been established.

Thursday, July 13

10 a.m.—Prof. Piwowarsky on the significance of mechanisation in the foundry.
10.30.—Mr. Vielwerth, of Badische Maschinenfabrik, Durlach, on foundry layout and foundry machines.
12.30.—Discussion.
3 p.m.—Dr. Crummenauer, of Frankfurt, on the development of compressed-air moulding machines in general, and of the Tabor-type in particular.
4 p.m.—Mr. A. von Arx, of the Von Roll Company, Switzerland, on practical results obtained from the different types of moulding machines.
5.30.—Discussion.

Friday, July 14

9.15 a.m.—A representative of the Gustav Zimmerman Company on foundry moulding machines.
10.15.—Mr. Becker, of Grane & Company, on sand-preparing machines and handling arrangements, with special reference to the Sandslinger.
11.15.—A representative of Vogel and Schemmann on coreblowing machines.
12.15.—Discussion.

Enamelling of Gas-cooker Components

By A. G. Thomson

IN JANUARY, 1945, a 1,000-lb. V2 rocket caused extensive destruction at the Gothic Works of R. & A. Main, Limited, the well-known gas-stove manufacturers, of Edmonton, London. Among other damage, the entire foundry roof was blasted off and about a quarter of the enamelling shop, including several furnaces, was smashed. Though foundry production was only suspended for some two weeks, this set-back disorganised the company's post-war programme of expansion and reconstruction.

Pilot Plant

To replace the enamelling equipment which had been destroyed, it was decided to try out a roller-hearth furnace of a very modern type. A pilot plant was therefore laid down, consisting of an automatic grip or undercoat dryer and a gas-fired continuous furnace. A general view of the enamel shop is shown in Fig. 1. The ware is passed through the dryer by means of a monorail (Fig. 2), from which the components are suspended and is then transferred to the furnace, making an almost continuous operation. Had this system proved entirely successful this plant would have been duplicated and possibly a third similar plant might have been laid down.

The total length of the continuous gas-fired furnace (Fig. 3) is 92 ft. from the extreme ends of the loading and unloading table. The actual firing chamber is 20 ft. long, while the pre-heating and cooling sections are each about 36 ft. long. The furnace is fully automatic, temperature being pyrometrically controlled. The ware is loaded on to perrits which travel continuously along roller conveyors, the speed being controlled by a variable gear. In the actual firing zone, where the temperature is usually from 790 deg. to 830 deg. C., the rollers are constructed of ceramics. The ware normally travels through the furnace at the rate of about 6 ft. per min. and on reaching the unloading table is lifted off the perrits.

A swinging conveyor arm carries the unloaded perrits down to a lower level to be returned by a similar conveyor underneath the oven to the loading table. The operation of the conveyor arm is controlled by a selenium cell, the current being switched on as the shadow of the perrit breaks a beam of light. On reaching the loading zone the perrit interrupts a second beam of light, thereby setting in motion a conveyor arm which lifts it up to the operator for reloading on the oven conveyor track. Normally 37 perrits are necessary to keep the oven continuously fed.

This furnace is at present working for 24 hours a day on 5½ days a week. In the initial stages the process was found to present certain difficulties. Not only were the firing perrits unable to stand up to the work and suffered serious damage during use, but their frames were too narrow to cut off the beam of light. The latter difficulty was overcome by increasing

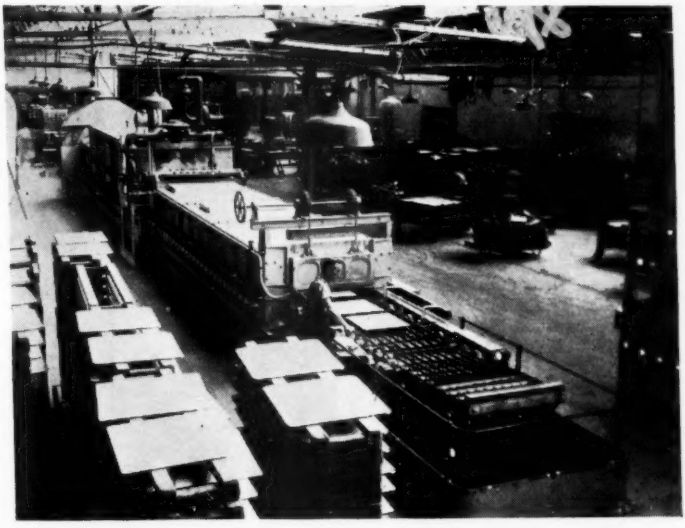


FIG. 1.—*View of the Enamel Shop at the Gothic Works of R. & A. Main, Limited.*

Photographs by courtesy of Incandescent Heat Company, Limited.

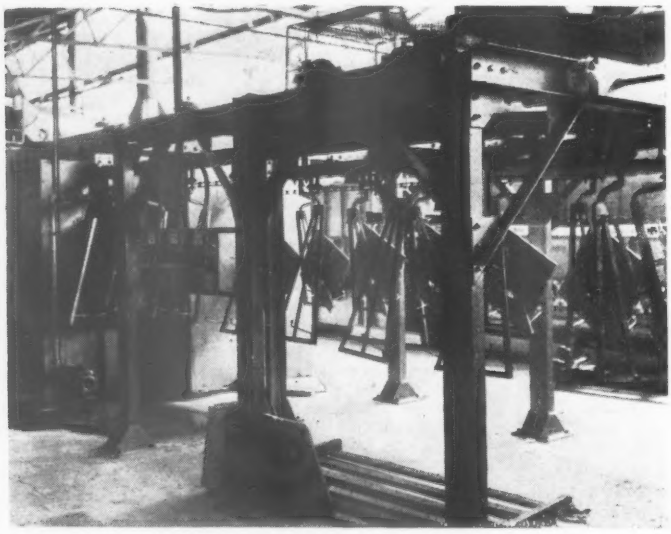


FIG. 2.—*Monorail carrying the Ware on Fabricated Hangers and Feeding the Automatic Grip-coat Drying Oven.*

the thickness of one side. At the same time the weight of the perrits was increased from 22 lb. to 28 lb. and subsequently to 32 lb. The method of construction has also been improved. Whereas the pins were originally welded on to the frame they are now detachable for replacement as required.

Although the heavier perrits proved strong enough for their purpose, the increased weight could not, of course, be offset by a corresponding increase in the quantity of ware passing through the furnace, so that the amount of heat absorption by the perrits is very much greater than before. Because of these difficulties it was decided that the second pilot plant should be of a different type. Another unit is now in process of being installed and is expected to come into operation in February. This new furnace incorporates the very latest improvements in enamelling practice, based partly on the company's own experience.

Improved Continuous Furnace

The improved furnace is also gas-fired and fully automatic. An interesting feature is that charging and emptying are carried out from the same end of the furnace, the components being suspended from grids hanging from a monorail. Heat from the outgoing ware provides the preheating for the grids entering the furnace. At the opening of the combustion chamber, a pressure of air is created which prevents heat from escaping into the cooling zone. The overhead system of charging is capable of taking bigger jobs and permits of a greater variation in dimensions and shape. A further advantage over the first pilot plant is that

FIG. 3.—*Continuous Gas-fired Furnace for Firing Enamel Ware. This 92-ft. Long Plant is fully Automatic.*

the grids are returned direct to the loading operator by the same conveyor on which they were loaded, thereby resulting in a considerable saving of time and labour.

These two plants are intended mainly for the enamelling of sheet-iron ware. The equipment of the enamel shop also includes a battery of four oil-fired muffle furnaces in which the firing of cast-iron products is normally undertaken. The loading gear is the normal hand-operated fork charger some 20 ft. long, embodying double forks. The charge remains in the oven for 20 to 30 min. at temperatures ranging from 720 deg. to 830 deg. C., time and temperature depending mainly on the weight of the castings and the type of enamel being used.

Process for Cast Iron

Castings to be enamelled are first shot-blasted at a pressure of about 100 lb. per sq. in. to remove every particle of rust or dirt and produce a perfectly clean face for enamel spraying. The equipment of the shot-blast department includes two Wheelabrators, one Tilghman, continuous-belt, shot-blast and three Tilghman turntable-type shot-blasting machines. After shot-blasting, the castings are coated with enamel by spraying; burners receive only one coat, but certain castings are given two coats. The spraying booths are arranged in line and are served by a fume- and dust-extraction plant. Each booth is equipped with screened lighting directed into the interior of the cabinet and so providing optimum conditions for the operator. Each cabinet contains a small turntable, so that all sides of the ware can be sprayed without handling the job. After spraying, most castings are dried in a conveyorised drier at a temperature of about 100 deg. F. On receiving their colour coats they are transported across the shop and placed on perrit supports resting on the forks previously described, which feed the enamelling ovens.

Both transfers and stencilling are employed for marking the ware. Stencilling is used only where the quantities involved are small, and is carried out by a series of masking and brushing operations. This work is undertaken by women between each firing operation.

Defective coats of enamel are stripped if the blemishes are such that an additional coat could not be applied without risk of blisters or patches, but where the blemishes are very small a further application of enamel can frequently be given without stripping.

Research and Development

A considerable amount of research and pioneer work has been carried out in developing new and better enamels of a superior chemical and heat resistance. These new enamels are of very high opacity and have superior appearance and durability in comparison with the types used before the war. In order to explore these new enamels and make them available to other manufacturers, a subsidiary company of R. & A. Main was formed under the trading name of Main Enamel Manufacturing Company, Limited. A valuable export trade to hard-currency countries has been secured.

Enamel Preparation

In the enamel-preparation section the raw materials* are weighed on a scale sensitive to ounces and loaded into hoppers which feed the mixers. After being thoroughly mixed, the batches are loaded into rotary-type smelters, fired by oil, and are smelted at temperatures ranging as a rule from 1,000 deg. C. to 1,200 deg. C. After smelting has been completed samples are taken and the smelt is discharged into cold running water, which breaks it up into the fine granules or frit.

The mill room where the frit is crushed is equipped with "Rohrbach" mills which are of German origin and were installed about 1930. These are used for pulverising the enamel frit to a very fine paste. The method employed is to load the frit into the mills with water and the necessary mill additions, following which a quantity of ordinary sea-shore pebbles from selected districts are added. These range from 1¼ in. to 2½ in. nominal diameter. The mills, which are provided with porcelain linings, are then rotated for the requisite number of hours to grind the enamels to their necessary fineness, which is equivalent to approximately 150 mesh.

Cream-like enamels are unloaded from the mills by means of air pressure and discharged into special containers provided for their reception. The enamels are passed through a vibratory sieve of 40 to 60 mesh dependent upon the properties required in that particular enamel. They are then tested for viscosity, which can be varied according to the amount of water used. This process of viscosity testing is very important as it determines the workability of the material in the shop. As will be readily appreciated, various enamels have their own particular optimum viscosity. The tests used at this works are those in general use throughout the country. When the enamel slip is thin enough to permit of flow through a small hole, the viscosity is compared by measuring the time taken for 200 ml. of enamel slip to flow under gravity through a predetermined orifice. Should the slip be too thick it will, of course, flow slowly, and if too thin it will flow rapidly.

* For a detailed account of the handling of the raw materials see "A Modern Handling Plant for Enamel Constituents," FOUNDRY TRADE JOURNAL, Vol. 59, page 106.

Industrialisation of S. Rhodesia

The report of the consultants, John Miles & Partners (London), Limited, to the Government of Southern Rhodesia on the expansion of the Que Que steelworks to produce 109,000 tons per annum of finished steel, plus 10,000 tons of foundry pig-iron, has recently been tabled in the Legislative Assembly. This extension, involving coke-oven plant, a new blast furnace, new steel plant and rolling mills, will, according to the report, cost £9,800,000, excluding housing, and it will result in gross earnings of £1,660,000 per annum.

The report emphasises that, with the large cheaply mined deposits of iron ore and limestone, together with Wankie coal, it is possible to produce some of the cheapest pig-iron in the world. It is estimated that the manufacturing cost of pig-iron at Que Que would be 69s. per long ton, whereas European costs vary from 145s. to 260s., and costs in the U.S.A. lie between 150s. and 185s. (£1 = $2.8).

Que Que is centrally located in the colony, being approximately equidistant from Bulawayo and Salisbury, the two principal towns, and is the centre of a thriving gold-mining industry. It is also the location of the new tube plant of Stewarts and Lloyds, Limited.

Some 40 miles away at Gwelo, a new ferro-chrome plant is being built by Rhodesian Alloys, Limited, a £1-million company recently founded by John Brown & Company, Limited, with the co-operation of the Anglo-America Corporation and the British South Africa Company, Limited. It will exploit the nearby chrome-ore deposits in a new modern plant. The consulting engineers are John Miles & Partners.

Raw Materials in Europe

Supply Position of the Iron and Steel Industry Reviewed

WHILE EUROPE as a whole is largely self-sufficient in coal and scrap and is largely, though not entirely, independent as regards iron ore, individual European steel-producing countries are in a very different position. An article in the British Iron and Steel Federation's latest "Statistical Bulletin" summarises the raw-material position of each of the more important countries, and shows how great is the dependence of all the European steel producers on one another. As this is background information which foundrymen should find useful when considering business trends the salient features from this report are reproduced.

France

France possesses an abundance of iron ore, although with a low iron content (24 per cent. to 41 per cent. Fe). Production reached 51 million tons in 1929, but has since declined, owing to circumstances which include the upsets of war, a shortage of labour and housing, and the natural reduction of the ease with which the ore can be won. Output in 1937 (the pre-war peak) was 38 million tons, and is now only 31 million tons. The deposits are mainly in the Lorraine area, although there are also deposits in Brittany and Normandy. As a consequence, the great bulk of France's steel industry is situated in the north-eastern part of the country. This area is expected to provide the major part of the ore requirements of Belgium, Luxemburg, and the Saar, in addition to those of France. With the fall in output of this ore and the lack of coke since the war, Belgium and Luxemburg have turned towards Sweden for supplies.

France is, however, seriously deficient in coking coal and has to import over half her metallurgical fuel, partly in the form of coal and partly in the form of coke. Experiments are being made in the blending of native coals of non-coking quality with coking coals in order to lessen the dependence on imported coal.

In the past, about two-thirds of French steel has been made by the basic-Bessemer process, for which the high-phosphorus home ores are suited. There have, therefore, always been adequate supplies of scrap from home sources to supply open-hearth furnaces.

More recently, the scrap supplies have been particularly plentiful and the proportion of Bessemer steel has dropped to 60 per cent. In the long-term plan, however, it is proposed to return to the pre-war proportions, and it is probably that France will continue to have a surplus of scrap for export.

The Saar

The future of the Saar coal mines is, of course, a matter of great importance to France. The Saar coals are not, however, of good coking quality and have to be blended with coking coal from the Ruhr. France and the Saar will, therefore, have to continue to rely on the Ruhr for most of their coking coal.

There are now no ore resources left in the Saar, so that large quantities have to be imported mostly from Lorraine. This is not a serious disadvantage, apart from political considerations, as the ore does not have to be transported far.

About 70 per cent. of the Saar's steel is made by the basic-Bessemer process and she is more or less self-sufficient in respect of scrap.

Germany

Germany possesses abundant supplies of good coking coal in the Ruhr and Aachen areas. In the long run, she is more favoured than any other Continental producing centre with regard to fuel supplies. Since the war, however, output in these mines has been a serious limitation on industrial recovery and only now is production approaching pre-war figures. This has been a major factor in limiting the output of the French, Belgian, Luxemburg, and, of course, the German steel industries.

The iron-ore position is very different. The resources of the old mining districts in the west are now becoming depleted and the ores, with an average Fe content of about 33 per cent., are difficult to win. The Salzgitter-Peine ores, in central Germany, are more abundant, but their iron content is very low. Only pressure from the occupying powers and currency limitations have pushed up their output over that of pre-war. Normally, half the German steel production is basic-Bessemer and half open-hearth quality; these ores are only suited to the basic-Bessemer process.

Germany has, therefore, always been dependent upon imported ore, the greater part of which has come from Sweden. Even when Lorraine was a part of Germany the Ruhr plants drew the bulk of their supplies from Sweden and, in fact, imported in some years two-thirds of the Swedish export.

Before the war, when Germany was producing over 20 million tons of steel, more than two-thirds of her ore was imported.

With the great reduction in pig-iron production, the problem of ore supplies has not been so pressing, but home ore production, at 9 million tons per annum, still supplies less than two-thirds of Germany's total requirements.

The scrap position is abnormally favourable at the moment, owing to war damage, and even after using 70 to 75 per cent. scrap on average in the open-hearth furnace charge and up to 25 per cent. scrap in the blast furnace, Germany has a surplus for export. Before the war, Germany was a net importer of scrap.

Belgium

The historical justification for the growth of the Belgian steel industry is the supply of native coal, and coking-coal reserves are still available. The industry is mainly concentrated in the coal areas around Charleroi and Liège. There is also a much smaller centre in the south, based on the ore deposits at the fringe of the Lorraine field. Actual Belgian reserves and production of ore are almost negligible. Normally, nearly all the ore used is the Lorraine "minette," most of it coming from the French fields and the rest from Luxemburg. Thus, Belgium, although she relies almost entirely on imports for her ore supplies, used to get the bulk of these from just across the border.

The post-war shortage of coke has led both Belgium and Luxemburg to turn to the high-grade ores of

Sweden to enrich the local supply. The recent easing of supplies of coke has revealed a tendency to return to normal sources for ore supplies. The extent to which normal movement will reappear will in part be determined by the degree of recovery achieved in Lorraine, now suffering from labour and housing troubles.

Since 90 per cent. of Belgian steel is made by the basic-Bessemer process, scrap requirements are small, and can be more than covered by scrap arising in the course of production.

Luxemburg

It is customary to consider Belgium and Luxemburg as a single entity, owing to the partial economic union and the common currency. There are, however, important differences in the raw-materials position of the two countries.

Luxemburg produces neither coking coal nor coke, and the necessary supplies, almost entirely in the form of coke, have to be hauled over long distances, primarily from the Ruhr, with small quantities from the Saar and the Belgian mines.

The industry has grown up on the Lorraine orefield, which extends into Luxemburg. The reserves are not large and may be exhausted in less than 25 years. Moreover, the iron content is low at this end of the field (averaging 30 per cent. compared with 38 per cent. on the best part). Ore production in 1949 was just over 4 million tons, rather less than half of which was exported; home requirements were made up by considerable imports from France and Sweden. The consumption of scrap is small, as in Belgium, because very little open-hearth steel is produced.

Italy

Italy is entirely dependent on imported coal, which has to be transported a considerable distance—from Germany, Poland, the United Kingdom, and, at present, the United States. Her ore resources are inadequate. Her output of steel, at present about 2 million ingot tons per annum, is almost exclusively by the open-hearth and electric processes (the latter relying to a large extent on hydro-electric power) and she is dependent on appreciable imports of scrap—of the order of 750,000 tons per annum—as well as of coal and ore.

Sweden

Sweden, a producer of a million to a million-and-a-half tons of steel per annum, is equally dependent upon imports of coal, but, on the other hand, she has some of the richest iron-ore deposits in the world and is one of the largest European exporters of iron ore, not only to other European countries, but, since the war, to the U.S.A.

Her exports of ore to-day differ radically from the pre-war pattern. Germany was for years her principal customer and took some 70 per cent. of her export deliveries, the United Kingdom being second with only about 15 per cent. Since the war Germany was out of the market until 1948 and is only gradually returning; the U.K., with its greatly increased steel production, is now the largest importer.

With the shortage of coke immediately after the war, Belgium and Luxemburg bought large quantities and the high steel production in the U.S.A. sent their buyers into this market to the extent of 1 or 2 million tons a year. Like Italy, Sweden produces steel primarily—though not exclusively—by the open-hearth and electric processes, and she is also normally a net importer of scrap of the order of 100,000 tons per annum.

United Kingdom

Large imports of iron ore are a feature of the United Kingdom's raw material supplies. Home ores are low in iron content and, although fairly plentiful, only meet under half the iron requirements. The industry, which produced 15½ million tons of steel in 1949, is mainly based on the large deposits of coking coals and the import of higher grade ores than those available from the home quarries. The principal suppliers of ore are Sweden and North Africa. Coal reserves are large and the United Kingdom has been a major exporter of coal.

The accompanying table, which shows for the post-war period up to 1948 the extent to which each country depends for steelmaking upon imports of raw materials, brings out strikingly the interdependence of the various countries, which are listed approximately according to the volume of their iron and steel production. It will be seen that, while some countries have more than enough coal and others have more than sufficient iron ore, there is no country which is independent in respect of both of these key materials. The outstanding feature is the large extent to which France depends upon imports of coal, while Germany and the United Kingdom depend upon imports of iron ore. In the case of the smaller countries, the deficiencies are relatively greater, Belgium, the Netherlands, and the Saar having no iron ore, while Luxemburg, Italy, and Sweden have no coal.

The table relates to the early post-war position. In consequence, it rather understates the German dependence on imported iron ore owing to the greatly reduced level of steel production. The British position also at the present time shows a rather larger dependence on imported ore and imported scrap.

Dependence of European Steel Producers on Imported Raw Materials

	Iron ore.	Scrap.	Coal.
	Per cent.	Per cent.	Per cent.
U.K.	45	10	—
France	—	—	50
Saar	100	—	
Germany	45	—	—
Belgium	100	20	25
Luxemburg ..	50		100
Italy	10	35	100
Sweden	—	20	100
Netherlands ..	100	—	—

NOTES.—Iron-ore percentages are based on iron content. The third column includes the coal equivalent of imported coke.

U.S. Steel Products Dearer

Three subsidiaries of the United States Steel Corporation — Carnegie-Illinois Steel Corporation, the National Tube Company, and the American Steel & Wire Company of New Jersey—introduced price increases for a wide variety of stainless steel products and galvanised steel pipes as from midnight on Wednesday.

Prices are raised from 1 cent to 1½ cents per lb. for stainless steel products, while the price of galvanised steel pipe is raised by $6 per net ton. Statements attribute the increases to the recent rises in the costs of nickel and zinc.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY held a conference on the "Fatigue and Fracture of Metals" at the Institute in Cambridge, Massachusetts, from June 19 to 22.

News in Brief

THE R.F.D. COMPANY, LIMITED, of Godalming, have recently designed a new type of goggle, in which special attention has been paid to the very important question of ventilation.

DESIGNED to give those interested the benefit of research carried out by Imperial Chemical Industries, Limited, an exhibition of I.C.I. technical literature opened last Tuesday at the Mitchell Library, Glasgow.

WORK ON THE making of a site for the construction of another tube mill and additional furnaces by Stewarts and Lloyds, Limited, at the rear of their Clydesdale Steelworks, Mossend, is now beginning to take shape.

FOUNDRY SUPPLIERS, LIMITED, London, have taken over the sole agency for London and the Home Counties for the well-known rolled-steel foundry moulding boxes, manufactured by the Bilston Stove & Steel Truck Company, Limited, Bilston.

THE WEST GERMAN GOVERNMENT has been informed that the Renn iron-ore processing works, formerly belonging to Krupps, at Watenstedt Salzgitter, is to be dismantled. The Lurgi iron-ore processing works in the same area may be retained.

MIDDLESBROUGH EDUCATION COMMITTEE has accepted an offer by Dorman, Long & Company, Limited, to award annually a silver medal, to be known as the Dorman Long Engineering Medal, for competition among students at Constantine Technical College.

RAPID MAGNETTING MACHINE COMPANY, LIMITED, Lombard Street, Birmingham, 12, announce that they are now in full production at their new factory, although the extensions to accommodate their laboratory and development staff have yet to be completed.

MR. ALFRED G. WEBB, a director and secretary of the Bryan Donkin Company, Limited, mechanical and gasworks plant engineers and ironfounders, of Chesterfield, has retired. He joined the firm in 1885, and since 1921 has been secretary also of British Furnaces, Limited, Chesterfield.

ON JUNE 24, some 60 members of the Shipley Mechanical Institute Engineering Society, together with their wives, toured the Stanton Ironworks at Nottingham. After inspecting the blast furnaces they were shown a film depicting the production of spun-iron pipes, and then visited the coke-oven plant.

PORT TALBOT TOWN COUNCIL has decided to give every possible assistance to the British Oxygen Company, Limited, in preparing plans for the construction of a new factory at Margam. It is understood that the factory is intended to supply gases to the strip mill of the Steel Company of Wales, Limited.

SIR LIONEL KEARNS presided over the annual general meeting of the Production Engineering Research Association, held at the Piccadilly Hotel, London, last week. The report which he presented shows that this young association is making very good progress. The bulletin of abstracts they publish is particularly well done.

THE "CHALLENGER," the latest crawler Diesel tractor, equipped with bulldozer attachment, was one of the many products on view to nearly 10,000 people who visited the works of Marshall Sons & Company, Limited, Gainsborough, last Saturday. It was the first time since the company was established 102 years ago that the works has been thrown open to the public.

CLEVELAND IRONSTONE MINERS have received new holiday-pay arrangements. For annual and statutory holidays, the maximum payment per day has been increased from 23s. to 24s. 9d., and men called upon to work on a statutory holiday are to be paid at the rate of time-and-a-half, in addition to receiving the full holiday pay. Time allowed for loss of work due to accidents has been increased from 24 to 36 shifts.

Mr. A. Roebuck Retires

At his own request, Mr. Alfred Roebuck, M.I.MECH.E., retired from the board of Hadfields, Limited, Sheffield, on June 30. Mr. Roebuck can remember the time when there were cornfields where the well-known East Hecla Works at Tinsley now stand. After serving his apprenticeship at these works, he was appointed an engineer's draughtsman, and at the beginning of the first world war was made assistant chief works engineer. In 1924 he was promoted to chief engineer, and later in 1929 he was one of the first six officials of the company who were appointed local directors. In 1931, Mr. Roebuck was elected a director of the company, following Mr. John Crosbie.

From 1939 to 1943, Hadfields controlled a shadow factory for the Ministry of Aircraft Production. Mr. Roebuck was engineering director in charge of construction, equipping, and production. The factory was situated at Swinton on the outskirts of Mexborough. Mr. Roebuck, particularly in later years, has given freely of his time and support to a large number of associations and professional institutions. He is a vice-president of the Institution of Mechanical Engineers and this year's president of the Junior Institution of Engineers, being inducted into this office by Sir Noel Ashbridge last December at the Royal Society of Arts. He is a member of the Institute of British Foundrymen, the Iron and Steel Institute, and the American Society of Mechanical Engineers. He is keenly interested in Sheffield University activities, being a member of the Court of Governors and serving on the University Engineering and Metallurgical Committee. Mr. Roebuck is a past-president of both the Sheffield Society of Engineers and Metallurgists and the Sheffield Metallurgical Association.

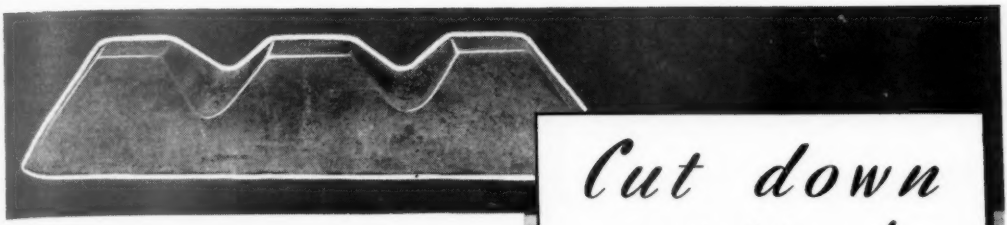
Mr. Roebuck wishes it to be understood that although he is easing up in some of his activities he will still have plenty to occupy his time. Hadfields, Limited, are retaining his services as consultant, and he will continue to act as a director of John Baker & Bessemer, Limited, Kilnhurst, Nr. Rotherham.

T.U.C. Wages Policy

Responsibility for wage levels has now been passed to the individual unions as a result of the T.U.C. General Council's abandonment of its policy of rigid wage restraint. The General Council's statement points out that the rigorous restraint of wages which the previous policy attempted to introduce cannot continue to operate, in view of the rising cost of living, and the apparent improvement in the economic situation. "There must now be greater flexibility of wage movements in the future than we envisaged in the policy approved by the conference of executives in January."

The General Council admits, however, that there is no formula which can be devised as to how this flexibility can operate. Its operation is left to the "good sense and reasonableness" of the unions, with a strong warning from the T.U.C. that the basic difficulties in the economic situation still remain, even if temporarily lessened in their intensity. In view of the lack of any practicable formula to guide unions in their wage policies, the General Council offers its services for direct consultation with any union needing assistance in considering its problems.

VICKERS-ARMSTRONGS, LIMITED, have received an order from the Venezuelan Government for two destroyers which will be built at Barrow.



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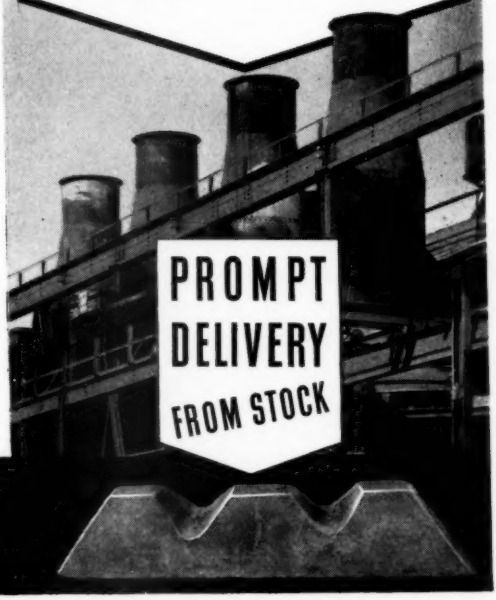
Stanton Foundry Pig Iron in all grades is also available in sand cast form.

We welcome enquiries on foundry problems and offer free technical advice.



PROMPT DELIVERY FROM STOCK

THE STANTON IRONWORKS COMPANY LIMITED - NEAR NOTTINGHAM

Iron and Steel in India

The claim that, with the possible exception of Australia, India was producing steel more cheaply than any country in the world was advanced by Sir Padamji Ginwala in a recent address to the Rotary Club of Calcutta.

The speaker recalled that before the war India produced the cheapest pig-iron in the world and exported hundreds of thousands of tons to the U.S.A., Great Britain and other countries in Europe, and to Japan. He believed they also made the cheapest steel. Exports were now impossible, as costs were not low enough to compete after paying freight, duty, etc.

Listing the reasons for the decline in India's competitive power, Sir Padamji Ginwala said that chief among them were the existence of a very large proportion of old, worn-out, and obsolete equipment, and an increase since the war of the order of 200 per cent. or more in the cost of all raw materials and in railway freights. Emoluments of labour employed in the industry had increased by more than 200 per cent., and had been accompanied by a decline in output per man-year of about 40 per cent. In England wages had increased by about 120 per cent., but the output per man-hour had risen by 31 per cent.

This was probably the least remediable of all their troubles. In the past, labour did not get a fair deal from the employers. But labour must also recognise that the position now was exactly reversed. In the iron and steel industry, mechanisation was the very soul of success and economy. Most of their equipment was as highly mechanised as any in other parts of the world before the war, and part of it more recently installed was as good as any installed elsewhere since the war. Yet they were employing, and were compelled to employ, about four times as many men as abroad for a corresponding output. On some units there were 10 times as many men as in the U.K. or the U.S.A.

Board Changes

PEGLERS, LIMITED—Mr. Wilfrid Wicks has been elected a director.

WALMSLEYS (BURY), LIMITED—Mr. Allan Green has been elected a director.

VONO, LIMITED—Mr. W. L. Barrows has been appointed a director and chairman in place of the late Mr. Bertram Silcock.

WILLENHALL MOTOR RADIATOR COMPANY, LIMITED—Mr. E. A. Collis has been appointed chairman, and Mr. A. Day and Mr. N. Robinson have been appointed additional directors.

NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, Glasgow—Mr. J. B. Mavor, M.I.MECH.E., has been appointed chairman. He joined the board of the company in 1944. He is also chairman of Mavor & Coulson, Limited, M. & C. Switchgear, Limited, and of the Regional Board for Scotland of the Scottish Engineering Employers' Association. Other appointments include directorship of the S.W. Scotland Electricity Board, Glasgow Chamber of Commerce, and the Trades House of Glasgow.

THE 55TH ANNUAL CONVENTION of the American Foundrymen's Society will be held in Buffalo, New York, from April 23 to 26, 1951. The Society last held a Convention in Buffalo in 1944. The 1951 Convention will be presided over by the president-elect, Mr. Walton L. Woody, of the National Malleable & Steel Castings Company, Cleveland, U.S.A., who assumes office this month.

House Organs

Contact, Vol 8, No. 2. Issued by the David Brown organisation, Huddersfield, and elsewhere.

The Editor, unlike many others responsible for the conduct of house organs, keeps a proper balance. If there has been a social function he may produce photographs—in fact one page is rather striking as everybody is shown with the right arm extended and smiling—but never descends to inventing a story when there really is not one. He has many works to cover and has rightly realised that what would please Fanny Smith of Huddersfield would bore John Jones at Coventry. He caters extremely well for a widely geographically separated circle of readers.

Nickel Bulletin, Vol. 23, No. 4. Issued by the Mond Nickel Company, Limited, Sunderland House, Curzon Street, London, W.1.

The mechanical use of permanent magnets has so far received much less attention in the Press than applications in the electrical field, so that special interest will attach to the article on this subject to be found in this issue; magnetic chucks, torque transmitters, welding clamps and lens-grinding magnets are among the items described in the article. There is also the usual collection of abstracts of current published information on nickel and its alloys.

Ruston News, Spring, 1950, Vol. 4, No. 2. Issued by Ruston & Hornsby, Limited, Lincoln.

Carrying a colourful cover illustrating the opening ceremony of the new Beevor foundry, this issue contains a wealth of worth-while articles on overseas conditions; gossip about the various works; apprentice movements; historical notes and all the usual features. For light relief a number of "600" magazine cartoons have been reproduced and no doubt are appreciated by the readers.

Broomwade News Bulletin, Vol. 13, No. 2. Issued by Broom & Wade, Limited, High Wycombe.

This issue gives notes on Mr. H. S. Broom's visit to Australia, New Zealand and South Africa; the appointment of Mr. A. C. Peffer as sales and service engineer in the north (he is located at 29, Brantford Avenue, West Monkseaton, Whitley Bay); the performance of an air compressor in Canada and a page of testimonials.

Osborn Foundry to Make American Equipment

Production of American-designed oil-refinery equipment has commenced at the Rutland Street foundry of the Osborn Foundry & Engineering Company, Limited, Sheffield.

Under a five-year agreement technicians from the Ohio Steel Foundry Company are coming to Great Britain to supervise production and train British workers. All designs necessary will be provided until the British company can supply their own. The scheme arose because of the American foundry's difficulty in exporting their products to the sterling area. It is estimated that £250,000 to £500,000 a year in dollars will be saved. Additional equipment is being acquired and about one-quarter of the firm's total moulding area will be devoted to this and similar work.

West German Pig-iron to be Dearer

Increases in the prices of hematite and foundry pig-iron of D.M.8 (13s. 8d.) per metric ton, as from July 1, have been agreed upon by representatives of the West German iron and steel industry, the foundry industry, and the Federal Ministry of Economics. Extras for certain qualities are unchanged.